Anekant Education Society's

# TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE & COMMERCE, BARAMATI, DIST – PUNE. AUTONOMOUS


## POST GRADUATE DEPARTMENT OF ZOOLOGY

## SYLLABUS

## M.Sc. Zoology Part-I, SEMESTER-II

Anekant Education Society's

**TULJARAM CHATURCHAND COLLEGE OF ARTS, SCIENCE & COMMERCE, BARAMATI.**

**AUTONOMOUS**

**Scheme of Course Structure (CBCS) Faculty of Science**

**Post Graduate Department of Zoology**

**SEMESTER II**

**Class: M.Sc. I** **Pattern: 50 (IA) + 50 (EA)**

| Sr. No. | Code | Paper | Paper Title | Credit | Exam | Marks |
|---|---|---|---|---|---|---|
| 1 | **ZOO:4201** | **Theory** | **Molecular Biology** | **4** | E/I | **60 + 40** |
| 2 | **ZOO:4202** | **Theory** | **Developmental Biology** | **4** | E/I | **60 + 40** |
| 3 | **ZOO:4203** | **Theory** | **Comparative Animal Physiology and Endocrinology** | **4** | E/I | **60 + 40** |
| 4 | **ZOO:4204** | **Theory** | **Biological Techniques** | **4** | E/I | **60 + 40** |
| 5 | **ZOO:4205** | Zoology **Practical-III** | **Practicals Corresponding to ZOO:4201 and ZOO:4202** | **4** | E/I | **60 + 40** |
| 6 | **ZOO:4206** | Zoology **Practical-IV** | **Practicals Corresponding to ZOO:4203 and ZOO:4204** | **4** | E/I | **60 + 40** |
| 7 | | **Skill Development** | | **2** | | |
| 8 | | **Introduction to Cyber Security – I** | | **2** | | |

**IA* - Internal Assessment**

**EA* - External Assessment**

**SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)**
**Academic Year 2019 – 2020**

**Class: M.Sc. I (Semester– II)**
**Paper Code: ZOO: 4201**
**Paper: I** **Title of Paper: Molecular Biology**
**Credit: 4** **No. of Lectures: 60**

**Course Objectives:-**

- Understand the organization and architecture of DNA within the nucleus.
- Explain the concept of supercoiling and its importance in DNA stability and unwinding.
- Explain the principles behind hyperchromicity, hypochromicity, and solubility of DNA.
- Analyze the concept of C-value paradox and its implications for genome complexity.
- Recognize and understand the roles of different RNA types (mRNA, rRNA, tRNA) in cellular processes.
- Elucidate the process of DNA replication in E. coli, including the role of origin, DNA polymerases, and regulatory mechanisms.
- Identify and categorize different types of DNA damage caused by various agents. Explain the roles and interactions of regulatory elements like promoter, enhancer, intron, exon, and silencer in gene expression.

**Course Outcomes:-**

**After completion of this course students will be able to -**

CO1: illustrate the structure of chromatin and differentiate between nucleosomes and higher-order DNA packing.
CO2: explain the impact of histone modifications on gene expression and chromatin remodeling.
CO3: analyze the relationship between DNA structure and its physical properties.
CO4: compare and contrast C-value paradox among different organisms.
CO5: explain the structure and functions of various RNA molecules in protein synthesis and other cellular processes.
CO6: draw and explain the steps involved in E. coli DNA replication.
CO7: classify different types of DNA damage based on their severity and potential consequences. Analyze the mechanism of gene transcription, including the role of RNA polymerase and sigma factor.

**TOPICS / CONTENTS:**

| | |
|---|---|
| **1. DNA Structure and Topology:** | **5 L** |
| Structure of chromatin, nucleosome, chromatin organization and re-modelling, higher order organization –Coiling, Supercoiling, chromosome, centromere, telomere, Histones and its effect on structure and function of chromatin, types of DNA | |
| **2. Physical properties of DNA:** | **2 L** |
| Tm, hypo and hyper chromicity, solubility, mutarotation and buoyancy | |
| **3. Genome organization:** | **4 L** |
| C value paradox and genome size, Cot curves, repetitive and non-repetitive DNA sequence, Cot ½ and, kinetic and sequence complexity, satellite DNA. Types of RNA and their significance | |
| **4. DNA Replication:** | **10 L** |
| DNA replication in E. coli, Origin of replication, types of E. coli DNA polymerases, details of replication process, regulation of replication, connection of replication to cell cycle. Different models of replication for linear and circular DNA, replication features of single stranded phages. Eukaryotic DNA replication, multiple replicons, structure of eukaryotic DNA polymerases, ARS in yeast, Origin RecognitionComplex (ORC), regulation of replication. | |
| **5. DNA Damage and Repair**: | **6 L** |

| | |
|---|---|
| Different types in DNA damages, Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, Double strand break repair, transcriptional coupled repair, Nick Translation, SOS Repair | |
| **6. Transcriptional Unit in Prokaryotes and Eukaryotes:** | **12 L** |
| Role and significance of promoter, enhancer, intron, exon, silencer, Transcriptional factors, mechanism of prokaryotic gene transcription, structure of RNA polymerase, post transcriptional processing: Capping, polyadenylation and splicing in eukaryotes. Ribonucleoproteins (Sn RNPs & Sc RNPs) | |
| **7. Genetic Code:** in prokaryotes and eukaryotes | **2 L** |
| **8. Protein synthesis in Prokaryotes and Eukaryotes**: | **7 L** |
| Ribosome structure, RNA Transport Mechanism, activation of amino acids, peptide bond formation and translocation of peptides, post-translational modifications, inhibitors of protein synthesis | |
| **9. Gene Regulation** | **6 L** |
| Lac Operon, Trp Operon, Arabinose Operon, pre and post transcriptional regulation, Post Translational Regulation | |
| **10. Mobile DNA elements:** | **4 L** |
| Transposable elements in bacteria, IS elements, composite transposons, replicative, non-replicative transposons, Mu transposition, Controlling elements in TnAandTn10transposition, SINES and LINES. Retroviruses and retro-transposon | |
| **11. Recombination :-** | **2 L** |
| Types of Recombination and Proteins involved in recombination | |

## REFERENCES


1. Genes IX, X , XI edition, Benjamin Lewin, Publisher - Jones and Barlett Publishers Inc.
2. Molecular Biology of the Gene, 5th Edition (2004), James D. Watson, Tania Baker,
3. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Lodwick. Publisher -
4. Pearson Education, Inc. and Dorling Kindersley Publishing, Inc.
5. Molecular Biology, 4th Edition (2007), Weaver R., Publisher-McGrew Hill Science.
6. Molecular Biology of the Cell, 4th Edition (2004), Bruce Alberts, Dennis Bray, Julian
7. Lewis, Martin Raff, Keith Roberts, and James D. Publisher: Garland Publishing.
8. Essential Cell Biology, 2nd Edition (2003) Bruce Albert, Dennis Bray, Karen Hopkin,
9. Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter, Publisher: Garland Publishing.
10. Fundamentals of Molecular Biology, (2009), Pal J.K. and Saroj Ghaskadbi, Publisher: Oxford University Press.
11. Lohar Prakash S. (2016) : Cell and Molecular Biology, MJP Publishers, Chennai MJP Publishers, Chennai ISBN 81-8094-027-6


**Course Articulation Matrix of ZOO: 4201: Molecular Biology**
**Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
|---|---|---|---|---|---|---|---|---|---|
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 3 | 2 | 3 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| CO6 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |
| CO7 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 3 |

**PO1: Disciplinary Knowledge:**
All of the COs are directly mapped to PO1. All COs are directly address PO1 by requiring knowledge of specific concepts in DNA structure, physical properties, genome organization, DNA replication, RNA types, and transcription.

**PO2: Critical Thinking and Problem Solving:**
All of the COs are directly mapped to PO2. For example- CO3, CO4, CO6 & CO7 Analyzing the relationship between DNA structure and properties, comparing c-value paradox, explaining replication steps, and classifying DNA damage all require critical thinking and problem-solving skills.

**PO3: Social Competence:**
All of the COs are directly mapped to PO3. All COs showing limited direct address. However, group discussions or problem-solving activities could indirectly address communication and collaboration skills.

**PO4: Research-related skills and Scientific temper:**
All of the COs are directly mapped to PO4. For example- CO6 & CO7 are drawing replication mechanisms and analyzing transcription process showcase basic research skills and scientific reasoning.

**PO5: Trans-disciplinary knowledge:**
All of the COs are directly mapped to PO5. For example- CO5 is connecting RNA functions to protein synthesis and other cellular processes demonstrates trans-disciplinary understanding.

**PO6: Personal and professional competence:**
All of the COs are directly mapped to PO6. For example- CO1, CO2, CO6 and CO7 are illustrating chromatin structures, explaining complex concepts, and drawing mechanisms require attention to detail and communication skills, contributing to PO6.

**PO7: Effective Citizenship and Ethics:**
All of the COs are directly mapped to PO7. All COs showing limited direct address. However, discussing the ethical implications of genetic engineering or potential environmental risks related to DNA research could indirectly touch on PO7.

**PO8: Environment and Sustainability:**
All of the COs are directly mapped to PO8. All COs showing limited direct address. However, mentioning environmentally relevant examples of DNA damage or emphasizing sustainable research practices could indirectly address PO8.

**PO9: Self-directed and Life-long learning:**
All of the COs are directly mapped to PO9. For example- CO2, CO4 and CO7 are explaining histone modifications, interpreting c-value paradox, and analyzing complex processes like transcription all encourage critical evaluation of information and independent learning, fostering PO9 skills.

**SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)**
**Academic Year 2019 – 2020**

**Class: M.Sc. I (Semester– II)**
**Paper Code: ZOO: 4202**
**Paper: II** **Title of Paper: Developmental Biology**
**Credit: 4** **No. of Lectures: 60**

**Course Objectives:-**

- Analyze the evolution of diverse developmental patterns from unicellular protists to multicellular metazoans.
- Explore key concepts and model systems used in developmental biology research.
- Understand the processes of spermatogenesis and oogenesis in detail.
- Deeply explore the intricate mechanisms and significance of fertilization.
- Analyze the key developmental stages following fertilization, including cleavage, blastulation, gastrulation, and pattern formation.
- Elucidate the activation of the egg and its transition to development.
- Grasp the role of organizers in establishing body plans and patterns.

**Course Outcomes:-**

**After completion of this course students will be able to –**

CO1: explain how developmental mechanisms evolved and diversified, comparing patterns across various organismal groups.
CO2: identify and describe the advantages and limitations of different model organisms like *C. elegans*, *Drosophila*, Zebra fish, frog, chick, and mouse.
CO3: analyze the formation, structure, and functions of sperm and egg cells, including factors like sperm motility, pH regulation, and maternal transcript storage.
CO4: explain pre-fertilization events like capacitation, species recognition, acrosome reaction, signal transduction, and molecular strategies ensuring monospermy and species specificity.
CO5: differentiate between various cleavage patterns, blastula types, and understand the concept of germ layer specification and animal-vegetal axis.
CO6: explain how the cell cycle is regulated and how maternal macromolecules and organelles are utilized during early embryonic stages.
CO7: analyze the function of Spemann's organizers in different model organisms like *X. laevis*, zebrafish, chick, and mammals, and explain their contribution to pattern formation.

**TOPICS / CONTENTS:**

| | |
|---|---|
| **1. Evolution of Developmental Patterns:**<br>The Evolution of developmental patterns in unicellular protists, multicellularity and developmental patterns among the metazoan | **4 L** |
| **2. Basic concepts of Developmental Biology:**<br>Model systems: *C. elegans*, Drosophila, Zebra Fish, Frog*(Xenopus laevis),* Chick, Mouse | **3 L** |
| **3. Gametogenesis:**<br>Spermatogenesis, regulation of sperm motility (tail fibre complex and role of dynein ATPase), role of pH and divalent cation. | **3 L** |
| **4. Oogenesis:**<br>Structure and Types of eggs and synthesis and storage of maternal transcripts, proteins and cell organelles, r-DNA amplification, transcription lampbrush chromosomes, vitellogenesis and its regulation | **5 L** |

| | |
|---|---|
| **5. Fertilization:** Types, Pre- fertilization events - Capacitation, Species specific sperm attraction, recognition of egg & sperm, acrosome reaction, signal transduction, molecular strategy to ensure monospermic and species-specificity in fertilization, Significance of Fertilization | **7 L** |
| **6. Post- Fertilization Events :** Cleavage patterns, Blastulation and types of Blastulae, Gastrulation gradients, Origin and Specification of germ layers Concepts in Pattern formation, animal vegetal axis. | **6 L** |
| **7. Egg activation:** Regulation of cell cycle and utilization of maternal macromolecules and organelles during early development. | **2 L** |
| **8. Organizers:** | **5 L** |
| Role of Spemann's organizers in X. laevis, Zebra fish, Chick and Mammal | |
| **9. Mesoderm Induction in Xenopus:** Role of signals in dorsal, intermediate and ventral mesoderm induction. | **3 L** |
| **10. Pattern formation in *Drosophila*:** | **3 L** |
| Bicoid, Nanos and Torso, Morphogen gradients and regulation of Hunchback | |
| **11. Neural competence and molecular signaling during neural induction:** | **3 L** |
| **12. Eye Lens Induction and Limb Development and regeneration in Vertebrates:** | **7 L** |
| **13. Cell Growth and Aging :** Concept of growth, differential cell proliferation, shaping of organ primordia and programmed morphogenetic cell death. | **2 L** |
| **14. Growth and post embryonic development:** Apoptosis and Necrosis, aging and senescence Hayflick's Experiment | **4 L** |
| **15. Cloning and Ethics:** | **3 L** |

## REFERENCES


1.Developmental Biology, 8th edition (2006), S.F. Gilbert. Publisher - Sinauer Associates Inc.

2.Principles of Development, 3rd edition (2007), Lewis Wolpert, Publisher- Oxford University Press.

3. An Introduction to Embryology, 5th edition (2004), B. I. Balinsky. Publisher - Thomas Asia Pvt. Ltd.

4. Developmental Biology, (2001), R. M. Twyman, Publisher - Bios ScientificPublishers LTD.


**Course Articulation Matrix of ZOO: 4202: Developmental Biology**
**Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO6** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO7** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |

**PO1: Disciplinary Knowledge:**
All of the COs are directly mapped to PO1. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are directly address PO1 by requiring knowledge of specific concepts in evolutionary developmental biology, model organisms, gametogenesis, fertilization, post-fertilization events, egg activation, and organizers.

**PO2: Critical Thinking and Problem Solving:**
All of the COs are directly mapped to PO2. For example CO1, CO4, CO5, CO6 & CO7 are analyzing the evolution of developmental patterns, understanding complex fertilization mechanisms, differentiating blastula types, explaining cell cycle regulation, and interpreting the role of organizers all require critical thinking and problem-solving skills.

**PO3: Social Competence:**
All of the COs are directly mapped to PO3. All COs showing limited direct address. However, group discussions or presentations on ethical issues in developmental biology could indirectly address communication and collaboration skills.

**PO4: Research-related skills and Scientific temper:**
All of the COs are directly mapped to PO4. CO1, CO2, CO3, CO4, CO5, CO6, CO7: Understanding complex biological processes, comparing different model systems, and analyzing regulatory mechanisms can indirectly contribute to research skills and scientific reasoning.

**PO5: Trans-disciplinary knowledge:**
All of the COs are directly mapped to PO5. All COs showing limited direct address. However, connecting developmental biology concepts to other fields like evolution, cell biology, and genetics could showcase trans-disciplinary understanding.

**PO6: Personal and professional competence:**
All of the COs are directly mapped to PO6. CO2, CO5, CO7: Analyzing advantages and limitations of model systems, differentiating complex structures like blastulae, and understanding organizer functions require attention to detail and critical thinking, contributing to PO6.

**PO7: Effective Citizenship and Ethics:**
All of the COs are directly mapped to PO7. All COs showing limited direct address. However, discussing the ethical implications of cloning technology or potential environmental concerns related to developmental interventions could indirectly touch on PO7.

**PO8: Environment and Sustainability:**
All of the COs are directly mapped to PO8. All COs showing limited direct address. However, mentioning examples of environment-sensitive developmental processes or emphasizing sustainable research practices could indirectly address PO8.

**PO9: Self-directed and Life-long learning:**
All of the COs are directly mapped to PO9. For example CO1, CO4, CO6 & CO7 are analyzing evolutionary trends, interpreting complex mechanisms like fertilization, understanding cell cycle regulation in early development, and critically evaluating the role of organizers all foster critical evaluation of information and independent learning, encouraging PO9 skills.

**SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)**
**Academic Year 2019 – 2020**

**Class: M.Sc. I (Semester– II)**
**Paper Code: ZOO: 4203**
**Paper: III Title of Paper: Comparative Animal Physiology& Endocrinology**
**Credit: 4 No. of Lectures: 60**

**Course Objectives:-**

- Understand the mechanisms and regulation of digestion and absorption in various animals.
- Analyze the diversity and effectiveness of different respiratory systems in animals.
- Gain in-depth knowledge of the structure and function of skeletal muscle tissue.
- Explore the mechanisms and adaptations animals employ to maintain internal water and electrolyte balance.
- Understand the processes and regulation of urine formation and waste elimination in animals.
- Analyze the physiological response of animals to temperature changes and their thermoregulatory strategies.
- Explore the role of hormones and other chemical messengers in animal physiology and behavior.

**Course Outcomes:-**

**After completion of this course students will be able to –**

CO1: explain the functional morphology of digestive organs, analyze enzymatic processes, and compare strategies for nutrient uptake across different taxonomic groups.
CO2: compare the mechanics of gas exchange in gills and lungs, explain the role of blood pigments, interpret oxygen dissociation curves, and discuss factors influencing CO2 transport.
CO3: illustrate the myofilaments organization, analyze the events at the neuromuscular junction, explain the actin-myosin interaction, and understand the role of calcium in contraction.
CO4: define key concepts like osmole, osmolality, and tonicity, differentiate hyper- and hypo-osmotic regulators, and analyze the strategies of ureosmotic animals.
CO5: detail the mechanisms of urine formation in the mammalian kidney, discuss renal pressure systems, and compare the biochemistry of nitrogen excretion across different taxa.
CO6: explain biokinetic zones, differentiate tolerance and resistance, apply thermobiological terminology, explain compensatory patterns in poikilotherms, and compare mechanisms of thermoregulation in homeotherms.
CO7: identify different types of hormones, describe the process of neurosecretion, compare invertebrate and vertebrate hormones, and analyze the mechanisms of hormone action through signal transduction pathways.

## Section I - Comparative Animal Physiology

**TOPICS / CONTENTS:**

| | |
|---|---|
| **1.Digestion:** | **4L** |
| Physiology of digestion, absorption and their regulation. | |
| **2.Respiration:** | **4L** |
| Respiratory Surfaces: comparison of ventilation associated with gills and pulmonary respiration. Blood pigment, role in Oxygen transport.$O_2$ dissociation curves-physiological and ecological significance, $CO_2$ transport | |
| **3.Muscle Contraction:** | **4L** |
| Structure (light & electron microscopic) of the skeletal muscle, proteins of the myo-filaments, events at Neuro- Muscular Junction ,nature of actinmyosin interaction., sarcoplasmic reticulum and role of Ca++ in contraction | |
| **4.Osmotic Regulation:** | **4L** |
| Concepts of Osmole, Osmolality and tonicity, Ionic Regulation, Hyper and hypo-osmotic regulators, ureosmotic animals | |
| **5.Excretion:** | **4L** |
| Processes& Detail mechanism of urine formation, renal function in animals specially the mammalian kidney, Renal pressure system, Comparative biochemistry of nitrogen | |

| | |
|---|---|
| excretion. | |
| **6.Temperature:** | **4L** |
| Biokinetic Zones, tolerance and resistance. Thermobiological terminology. | |
| Compensatory patterns in piokilotherms, Critical temp, and zone of thermal | |
| neutrality. Mechanism of thermoregulation in homeotherms. | |
| **7. Nervous System :** | **3L** |
| Anatomy of Brain, Comparative Physiology of Nervous system, Origin and Conduction Nerve Impulse, Nerve Excitation | |
| **8.Sense Organs:** | **3L** |
| Classification & functions (details of photoreception as a model).Reflexes, | |
| Principles of neural integration. | |

## Section II – ENDOCRINOLOGY

**TOPICS / CONTENTS:**

| | |
|---|---|
| **1. Chemical Communication:** | **3 L** |
| Hormones as chemical messenger, structure of hormones Neurosecretion, neurohemal and endocrine organs. Chemistry of Invertebrate and vertebrate hormones. | |
| **2.Hormone Receptors:** | **3 L** |
| Receptors on the plasma membrane, cytoplasm & nucleus and Mechanism of hormone action- signal transduction cascade | |
| **3.Hypothalamic Hypophysiotropins** | **2L** |
| **4.Adenohypophysial Hormones:** | **2L** |
| FSH, LH, ACTH, PRL, STH and TSH | |
| **5.Control of Chromatophores:** | **2L** |
| Pituitary and Pineal | |
| **6.Hormonal Regulation of Carbohydrates, Protein &Lipid metabolism:** | **3L** |
| Pancreatic Hormones and Glucocorticoids | |
| **7.Osmoregulatory Hormones:** | **2L** |
| ADH, mineralocorticoids, renin-angiotensin | |
| **8.Gastrointestinal Hormones** | **2L** |
| **9.Control of calcium and Phosphate Metabolism** | **2L** |
| **10.Endocrine Mechanism in Crustacean:** | **3 L** |
| X & Y organs, regulation of metabolism, heart, salt and water balance, reproduction, | |
| **11.Hormonal Control in Oogenesis of Amphibia:** | **2L** |
| Yolk Synthesis, Secretion &Uptake | |
| **12. Hormonal Regulation of in Cephalopod Molluscs and Echinoderms:** | **2L** |
| Reproductive System and Their Regulation | |
| **13.Hormones Regulation in Insect and Frog:** | **2L** |
| Larval Development and Metamorphosis | |

## REFERENCES


1. Comparative Animal Physiology, Clifford Ladd Prosser, John Wiley & Sons
2. Animal physiology, Richard W. Hill, Gordon A. Wyse. Harper and Row
3. Comparative animal physiology, Philip Carew Withers, Saunders College Pub., 1992
4. Bentley, P.J. (1998). Comparative vertebrate endocrinology, edn.3, Cambridge University Press, London.
5. Bollander, F. (1994). Molecular endocrinology, edn.2, Acad. Press, San Diego.
6. Hadely, M.E. (1996). Endocrinology. Edn.4, Prentice Hall, Upper Saddle Park.
7. Thomdyke, M.C. and Goldsworthy, G.J. (1988). Neurohormones in Invertebrates. Cambridge University Press.
8. Hoar, W.S. and Hickman, C.P., Jr. (1983). A laboratory companion for general and comparative physiology. Edn.3, Prentice - Hall, Englewood Cliffs, N.J., USA.
9. Kobayashi, H. Malsumolo, A. and Ishii, S. (Eds.) (1992).Atlas of endocrine organs: vertebrates and invertebrates. Springer Verlag, Berlin.

10. Zarrow, M.X., Yachim, J.M. and McCarthy, J.L. (1964). Experimental endocrinology: a sourcebook of basic techniques. Academic Press, New York
11. Lohar Prakash S. (2012) : Endocrinology : Hormones and Human Health, MJP Publishers, Chennai ISBN 81-8094-011-X

**Course Articulation Matrix of ZOO: 4203: Comparative Animal Physiology& Endocrinology**
**Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO6** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO7** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |

**PO1: Disciplinary Knowledge:**
All of the COs are directly mapped to PO1. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are directly address PO1 by requiring knowledge of specific concepts in digestive physiology, respiratory physiology, muscle contraction, osmotic regulation, excretory physiology, temperature regulation, and chemical communication.

**PO2: Critical Thinking and Problem Solving:**
All of the COs are directly mapped to PO2. For example CO2, CO3, CO4, CO5, CO6 & CO7 are analyzing the differences and adaptations in gas exchange (CO2), understanding the complex mechanisms of muscle contraction (CO3), interpreting complex regulatory systems in excretion (CO5), differentiating thermoregulatory strategies (CO6), and explaining hormone action pathways (CO7) all require critical thinking and problem-solving skills.

**PO3: Social Competence:**
All of the COs are directly mapped to PO3. All COs showing limited direct address. However, group discussions or presentations on comparative physiology or environmental implications of animal thermoregulation could indirectly address communication and collaboration skills.

**PO4: Research-related skills and Scientific temper:**
All of the COs are directly mapped to PO4. For example CO1, CO2, CO5, CO6 & CO7 are understanding complex physiological processes like digestion, gas exchange, and renal function (CO1, CO2, CO5), analyzing thermoregulatory adaptations (CO6), and interpreting hormone action pathways (CO7) can indirectly contribute to research skills and scientific reasoning.

**PO5: Trans-disciplinary knowledge:**
All of the COs are directly mapped to PO5. CO1, CO2, CO4, CO6, CO7: Connecting digestive physiology to nutritional ecology (CO1), comparing respiratory mechanisms to evolutionary contexts (CO2), linking osmoregulation to environmental adaptations (CO4), relating thermoregulation to animal distribution and behavior (CO6), and understanding the role of hormones in reproduction and development (CO7) showcase trans-disciplinary thinking.

**PO6: Personal and professional competence:**
All of the COs are directly mapped to PO6. For example CO2, CO3, CO5, CO6 and CO7 are analyzing complex data like oxygen dissociation curves (CO2), explaining intricate mechanisms like muscle contraction (CO3), interpreting detailed diagrams of renal structures (CO5), applying thermoregulatory terminology (CO6), and summarizing hormone action pathways (CO7) require attention to detail and communication skills, contributing to PO6.

**PO7: Effective Citizenship and Ethics:**
All of the COs are directly mapped to PO7. All COs showing limited direct address. However, discussing the ethical implications of hormone use in livestock or potential environmental challenges related to animal waste management could indirectly touch on PO7.

**PO8: Environment and Sustainability:**
All of the COs are directly mapped to PO8. For example CO4, CO5 & CO6 are analyzing adaptations for water balance in different environments (CO4), understanding the impact of waste products on ecosystems (CO5), and discussing the influence of climate change on thermoregulation (CO6) can indirectly address PO8.

**PO9: Self-directed and Life-long learning:**
All of the COs are directly mapped to PO9. For example CO2, CO3, CO5, CO6 & CO7 are analyzing complex data like oxygen dissociation curves (CO2), understanding the nuances of muscle contraction mechanisms (CO3), interpreting renal function in different animals (CO5), evaluating thermoregulatory adaptations in diverse environments (CO6), and critically exploring diverse hormone pathways (CO7) all foster critical evaluation of information and independent learning, encouraging PO9 skills.

**SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)**
**Academic Year 2019 – 2020**

**Class: M.Sc. I (Semester– II)**
**Paper Code: ZOO: 4204**
**Paper: IV Title of Paper: Biological Techniques**
**Credit: 4 No. of Lectures: 60**

**Course Objectives:-**

- Understand the principles and applications of various microscopy techniques for visualizing biological structures at different scales.
- Gain expertise in using spectroscopic methods to analyze the chemical composition and structure of biomolecules.
- Master the separation and characterization of proteins and nucleic acids based on their size and charge using electrophoresis techniques.
- Comprehend the principles and applications of centrifugation for isolating and analyzing biomolecules based on their size and density.
- Develop a strong foundation in separation and purification techniques based on different chromatographic principles.
- Gain practical skills in tissue preparation, staining, and visualization for microscopic analysis.
- Understand the principles and applications of cutting-edge molecular biology techniques in research and diagnostics.

**Course Outcomes:-**

**After completion of this course students will be able to –**

CO1: analyze the strengths and limitations of Phase Contrast, Fluorescence, Confocal, TEM, SEM, AFM, and Live Cell Imaging techniques, and apply them to study diverse biological samples.

CO2: explain the principles of UV-Vis, Atomic Absorption, Molecular, IR, NMR, and X-Ray Crystallography techniques, interpret spectra to identify functional groups and structure of biomolecules, and utilize advanced methods like Circular Dichroism and MALDI-TOF.

CO3: differentiate between Moving Boundary and Zone Electrophoresis, compare various electrophoresis supports, interpret results from Native and SDS-PAGE, and analyze complex protein mixtures using 2D-Gel Electrophoresis.

CO4: explain the theoretical basis of Ultracentrifugation, distinguish between Differential and Density Gradient Centrifugation, utilize centrifugation for molecular weight determination, and understand its diverse applications in biological research.

CO5: compare and contrast Paper, Thin Layer, Adsorption, Partition, Ion-Exchange, Affinity, and Molecular Exclusion Chromatography methods, choose appropriate techniques for specific biomolecules, analyze results from chromatographic assays, and utilize advanced techniques like GC-MS, HPLC, and HPTLC.

CO6: identify different types of fixatives and their roles, practice various sectioning techniques, apply histochemical and immunohistochemical staining methods, and utilize immunofluorescence for cellular localization studies.

CO7: explain the principles of Real-time PCR, DNA Microarray, Next-Generation DNA Sequencing, Protein Microarray, and FRET analysis, discuss their significance in research areas like gene expression, disease diagnosis, and protein-protein interactions, and interpret data generated from these techniques.

**TOPICS / CONTENTS:**

| | |
|---|---|
| **1. Microscopy:** | **7 L** |
| Principles and Applications of Phase Contrast Microscopy, Fluorescence Microscopy, Confocal Microscopy, Transmission And Scanning Electron Microscopy, Atomic Force Microscopy and Live Cell Imaging, FACS Analysis | |
| **2. Spectroscopy:** | **8 L** |

| | |
|---|---|
| UV-Visible Spectroscopy, Atomic Absorption Spectroscopy, Molecular Spectroscopy, IR Spectroscopy, NMR And X-Ray Crystallography, Circular Dichroism, MALDI-TOF | |
| **3. Electrophoresis:** | **6 L** |
| Moving Boundary Electrophoresis, Zone Electrophoresis, Different Supports Used for Electrophoresis, Native And SDS-PAGE, 2D- Gel Electrophoresis | |
| **4. Centrifugation:** | **6 L** |
| Principle, Basic Theory of Ultracentrifuge, Differential and Density Gradient Centrifugation, Molecular Weight Determination and Its Applications | |
| **5. Chromatography:** | **7 L** |
| Principles and Applications of: Paper and Thin Layer Chromatography, Adsorption Chromatography Partition Chromatography, Ion-Exchange Chromatography, Affinity Chromatography, Molecular Exclusion Chromatography, Thin Layer Chromatography, GC-MS, HPLC, HPTLC. | |
| **6. Histological Techniques:** | **5 L** |
| Types of Fixatives, Sectioning of Tissues, Histochemical Staining, Immunohistochemistry, Immunofluorescence | |
| **7. New Generation Techniques:** | **6 L** |
| Real time PCR, DNA microarray, New generation DNA sequencing, Protein Microarray, protein sequencing, FRET analysis | |
| **8. Computer Application:** | **5 L** |
| Introduction to Bioinformatics, Databases and Their Applications | |
| **9. Cell Culture Techniques:** | **7 L** |
| Introduction, The cell culture laboratory and equipment, Aseptic techniques and good cell culture practice, Types of animal cell, characteristics and maintenance in culture, Stem cell culture and Potential use of cell cultures | |

## REFERENCES


1. Principles and Techniques of Biochemistry and Molecular Biology, 6th edition (2008), Keith Wilson and John Walker, Publisher–Cambridge University Press.
2. Light Microscopy in Biology: A Practical Approach, 2nd edition (1999), Alan J. Lacey, Publisher–Oxford University Press.
3. Electron Microscopy: Principles and Techniques for Biologists, (1992), Lonnie D. Russell, Publisher-Jones & Bartlett
4. O'conner, M. and Woodford, F.P. Writing scientific papers in English. Elsevier – Ecerpata Medica-North Holland Publ., Amsterdam.
5. Trelease, S.F. How to write Scientific and Technical papers. Williams & Willikins Co., Baltimore, USA.
6. Day, R.A.How to write and publish a Scientific Paper. Cambridge University Press
7. McMillan, V.E., writing Papers in the Biological Sciences, W.H.Freeman, NY
8. Principles and Techniques of Biochemistry and Molecular Biology, Wilson K and Walker J.M., Cambridge University Press
9. Biophysical& Biochemical Techniques, Wilson K and Walker J.M.,
10. Laboratory Exercises and techniques in Cellular Biology, Anthony Contanto, Wiley Publ.2012
11. Histological and Histochemical methods: Theory and Practice, Kiernan J.A. Scion Publ.
12. Lohar Prakash S.( 2014) : Bioinformatics, MJP Publishers, Chennai ISBN 978-81-8094- 066-8

**Course Articulation Matrix of ZOO: 4204: Biological Techniques**
**Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO6** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO7** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |

**PO1: Disciplinary Knowledge:**
All of the COs are directly mapped to PO1. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are directly addressing PO1 by requiring significant knowledge of specific instrumentation techniques in microscopy, spectroscopy, electrophoresis, centrifugation, chromatography, histology, and new generation techniques.

**PO2: Critical Thinking and Problem Solving:**
All of the COs are directly mapped to PO2. For example CO1, CO2, CO3, CO4, CO5 & CO7 are Choosing the appropriate microscopy technique for a specific sample (CO1), interpreting complex spectra for biomolecule identification (CO2), troubleshooting electrophoresis data for protein characterization (CO3), selecting the best centrifugation method for molecular weight determination (CO4), analyzing chromatographic data to purify specific biomolecules (CO5), and interpreting results from new generation techniques for research applications (CO7) all require critical thinking and problem-solving skills.

**PO3: Social Competence:**
All of the COs are directly mapped to PO3. All COs showing limited direct address. However, group projects analyzing microscopy images, discussing data from electrophoresis gels, or interpreting results from new generation techniques could indirectly address communication and collaboration skills.

**PO4: Research-related skills and Scientific temper:**
All of the COs are directly mapped to PO4. For example CO1, CO2, CO4, CO5, CO6 & CO7 are utilizing diverse instrumentation techniques for research projects (CO1, CO2, CO4, CO5, CO6), designing and executing experiments with appropriate controls (CO4, CO5), and critically evaluating data generated from these techniques (CO7) all contribute to research skills and scientific reasoning.

**PO5: Trans-disciplinary knowledge:**
All of the COs are directly mapped to PO5. For example CO2, CO5 & CO7 are connecting spectroscopy techniques to chemical principles (CO2), relating chromatographic methods to biomolecule properties (CO5), and understanding the applications of new generation techniques in various fields like genetics, medicine, and forensics (CO7) showcase trans-disciplinary thinking.

**PO6: Personal and professional competence:**
All of the COs are directly mapped to PO6. For example CO1, CO2, CO3, CO6 & CO7 are operating instruments with precision and care (CO1, CO6), analyzing complex data sets and generating concise reports (CO2, CO3, CO5, CO7), and adhering to safety protocols in the laboratory (CO1, CO2, CO3, CO4, CO5, CO6) all require attention to detail, critical thinking, and communication skills, contributing to PO6.

**PO7: Effective Citizenship and Ethics:**
All of the COs are directly mapped to PO7. All COs showing limited direct address. However, discussing the ethical implications of using specific techniques like DNA sequencing in genetic testing or exploring the environmental impact of certain reagents used in these experiments could indirectly touch on PO7.

**PO8: Environment and Sustainability:**
All of the COs are directly mapped to PO8. All COs showing limited direct address. However, emphasizing the use of environmentally friendly protocols, minimization of waste generated during experiments, and responsible disposal of reagents could indirectly address PO8.

**PO9: Self-directed and Life-long learning:**
All of the COs are directly mapped to PO9. For example CO1, CO2, CO5, CO6 & CO7 are keeping up with advancements in instrumentation techniques (CO1, CO2, CO5, CO7), troubleshooting issues without relying solely on instructors (CO3, CO4, CO5, CO6), and independently interpreting complex data from various techniques (CO2, CO5, CO7) all foster critical evaluation of information and independent learning, encouraging PO9 skills.

**SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)**
**Academic Year 2019 – 2020**

**Class: M.Sc. I (Semester– II)**
**Paper Code: ZOO: 4205**
**Paper: V** **Title of paper: Zoology Practical-III**
**(Practicals Corresponding to ZOO: 4201, ZOO: 4202)**
**Credit: 4** **No. of Practical: 20**

**Course Objectives:-**

- Gain hands-on experience in estimating DNA and RNA concentrations using colorimetric assays and UV spectrophotometry.
- Develop skills in isolating DNA from diverse biological samples and analyzing its integrity and size using agarose gel electrophoresis.
- Understand and apply the Western blotting technique for protein detection and localization in biological samples.
- Investigate early embryonic development of chicks through dissection, mounting, and histological analysis.
- Explore developmental processes in different model organisms like Drosophila and frog using live observations and microscopy techniques.
- Investigate pattern formation and regeneration processes in chick limb buds and lower organisms like *Hydra* and *Planaria*.
- Develop the ability to combine different experimental techniques, analyze data from various sources, and draw meaningful conclusions about developmental processes.

**Course Outcomes:-**

**After completion of this course students will be able to –**

CO1: isolate DNA and RNA from different sources, quantify their concentrations accurately, and analyze the purity of isolated nucleic acids.
CO2: isolate DNA from bacteria, animal tissues, and plasmids, analyze its fragmentation patterns on gels, and calculate molecular weight.
CO3: perform Western blotting with primary and secondary antibodies, visualize specific proteins on membrane blots, and interpret the results in the context of protein expression patterns.
CO4: observe major organ systems of chick embryos at different stages, prepare histological sections, and identify key developmental events in organs like brain, heart, lens, and ear.
CO5: analyze egg structure and early development in Drosophila, study embryonic and post-embryonic stages in frog, and understand the influence of experimental manipulations like ligature on development.
CO6: visualize morphogenetic cell death in chick limb buds using neutral red staining, observe and analyze regeneration patterns in *Hydra* and *Planaria*, and explore the role of Hensen's node in chick development.
CO7: interpret results from molecular biology and developmental biology practicals, integrate their findings into a broader understanding of development, and communicate their insights effectively.

**PRACTICALS:**

**Section I ZOO: 4201 – Molecular Biology**

| Sr. No. | Name of the Practical |
|---|---|
| 1. | Estimation of DNA by diphenyl amine reagent. |
| 2. | Estimation of RNA by orcinol reagent. |
| 3. | Isolation of bacterial DNA and estimation by UV spectrophotometry. |
| 4. | Isolation of DNA from sheep/chicken liver. |
| 5. | Quantification of isolated DNA by agarose gel electrophoresis. |
| 6. | Isolation of RNA from biological sample. |
| 7. | Isolation of plasmid from bacteria. |
| 8. | Study of UV light/mutagen induced DNA damage through comet assay. |
| 9. | Detection of protein by Western blotting technique. |

**Section II ZOO 4202 – Developmental Biology**

| Sr. No. | Name of the Practical |
|---|---|
| 1. | Mounting of chick embryos and preparation of permanent mounts. |
| 2. | Filter paper ring method for in vitro culturing of chick Embryo & observations. |
| 3. | Gross anatomy and histology of chick embryo upto 72 hrs. Brain, heart, lens, ear development |
| 4. | Drosophila development on live material: egg structure, egg laying and early development in culture by phase contrast |
| 5. | Study of embryonic and post-embryonic development using frog egg as a model system. |
| 6. | Study of effect of ligature in Drosophila / House fly larva |
| 7. | Study the imaginal disc in Drosophila larva |
| 8. | Chick limb bud staining with neutral red for morphogenetic cell death |
| 9. | Study of grafting of Hensen's node. |
| 10. | Regeneration of Hydra/Planaria. |

**Course Articulation Matrix of ZOO: 4205: Zoology Practical-III**
**Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 2 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO6** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 2 | 3 |
| **CO7** | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |

**PO1: Disciplinary Knowledge:**
All of the COs are directly mapped to PO1. For example CO1, CO2, CO3, CO4, CO5 & CO6 are directly address PO1 by requiring knowledge of specific techniques in nucleic acid isolation, protein detection, chick embryo development, and model organism development.

**PO2: Critical Thinking and Problem Solving:**
All of the COs are directly mapped to PO2. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are troubleshooting technical issues in isolation procedures (CO1, CO2), interpreting gel electrophoresis results for DNA size and fragmentation (CO2), analyzing the specificity of antibody binding in Western blots (CO3), identifying developmental stages in chick embryos (CO4), understanding the effects of experimental manipulations on development (CO5, CO6), and drawing conclusions from combined data sets (CO7) all require critical thinking and problem-solving skills.

**PO3: Social Competence:**
All of the COs are directly mapped to PO3. All COs showing limited direct address. However, collaborative data analysis, group discussions on experimental results, and peer teaching during protocol demonstrations could indirectly address communication and collaboration skills.

**PO4: Research-related skills and Scientific temper:**
All of the COs are directly mapped to PO4. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are applying learned techniques to investigate specific research questions (CO1, CO2, CO3), maintaining accurate lab records and data analysis (CO4, CO5, CO6), critically evaluating results and drawing objective conclusions (CO7) all contribute to research skills and scientific reasoning.

**PO5: Trans-disciplinary knowledge:**
All of the COs are directly mapped to PO5. For example CO3, CO4, CO5, CO6 & CO7 are relating protein expression patterns to developmental processes (CO3), connecting chick embryo observations to human development (CO4), comparing developmental mechanisms across different model organisms (CO5), and integrating molecular data with morphological observations (CO6, CO7) showcase trans-disciplinary thinking.

**PO6: Personal and professional competence:**
All of the COs are directly mapped to PO6. For example CO1, CO2, CO3, CO4, CO5 & CO6 are following safety protocols meticulously in practical sessions (CO1, CO2, CO3), independently performing complex procedures with precision (CO1, CO2, CO3), managing time effectively during experiments (CO4, CO5, CO6), and documenting results clearly and concisely (CO7) all require attention to detail, organization, and communication skills, contributing to PO6.

**PO7: Effective Citizenship and Ethics:**
All of the COs are directly mapped to PO7. All COs showing limited direct address. However, discussing the ethical implications of using animal models in research or the environmental impact of lab waste disposal could indirectly touch on PO7.

**PO8: Environment and Sustainability:**
All of the COs are directly mapped to PO8. All COs showing limited direct address. However, emphasizing green lab practices, minimizing reagent waste, and responsible disposal of chemicals could indirectly address PO8.

**PO9: Self-directed and Life-long learning:**
All of the COs are directly mapped to PO9. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are independently troubleshooting technical issues (CO1, CO2, CO3), adapting protocols to new research questions (CO4, CO5, CO6), critically evaluating and updating experimental approaches based on new findings (CO7) all foster independent learning and a willingness to adapt to new knowledge and techniques, encouraging PO9 skills.

**SYLLABUS (CBCS) FOR M.Sc. ZOOLOGY (w. e. f. June, 2019)**
**Academic Year 2019 – 2020**

**Class: M.Sc. I (Semester– II)**
**Paper Code: ZOO: 4206**
**Paper: VI** **Title of paper: Zoology Practical-IV**
**(Practicals Corresponding to ZOO: 4203, ZOO: 4204)**
**Credit : 4** **No. of Practical: 20**

**Course Objectives:-**

- Analyze and compare nitrogenous waste products (ammonia, urea, uric acid) across animals from different habitats.
- Investigate the relationship between body size and oxygen consumption in aquatic animals using respirometry techniques.
- Develop skills in estimating biochemical parameters like sugar, chloride, and lactate in the blood of various organisms.
- Design and execute experiments to assess the effect of insulin on blood sugar levels in mammals (rats).
- Measure and analyze the influence of temperature and ions on the heartbeat rhythm of crabs.
- Dissect and analyze neurosecretory and endocrine structures in invertebrates and vertebrates using histological techniques.
- Perform surgical procedures like gonadectomy and thyroid removal in mammals and observe the consequences on relevant physiological parameters.

**Course Outcomes:-**

**After completion of this course students will be able to –**

CO1: identify physiological adaptations related to water conservation and nitrogen excretion efficiency in various animal groups.
CO2: analyze the influence of metabolic rates and diffusion limitations on oxygen use in aquatic animals of different sizes.
CO3: analyze the role of these components in physiological functions and interpret variations in their levels under different conditions.
CO4: gain hands-on experience in studying hormonal regulation of metabolism and interpret the role of insulin in glucose homeostasis.
CO5: investigate the neuronal and hormonal control of cardiac function in invertebrates and appreciate the adaptations for environmental fluctuations.
CO6: visualize and compare the anatomical organization of hormonal production and release systems in different animal groups.
CO7: visualize the role of specific hormones in regulating key physiological functions and analyze the effects of their depletion or modulation.

**PRACTICALS:**

**Section –I: ZOO: 4203 Comparative Animal Physiology (Any 5)**

| Sr. No. | Name of the Practical |
|---|---|
| 11. | Study of nitrogenous waste products of animals from different habitats. |
| 12. | Body size and oxygen consumption in aquatic animals (crab/fish). |
| 13. | Estimation of sugar and chloride content in rat/crab/human blood. |
| 14. | Effect of insulin on the blood sugar of rat. |
| 15. | Estimation of lactate content of rat/crab/human blood. |
| 16. | Determination of the heart beat in the crab-effect of temperature & ions. |
| 17. | Effect of eye stalk ablation on chloride & glucose in the haemolymph of the crab. |

**Section –II: ZOO: 4203 Endocrinology (Any 5)**

| Sr. No. | Name of the Practical |
|---|---|
| 1. | Histology of invertebrate and vertebrate neurosecretory and endocrine structures. |
| 2. | Staging of fish chromatophores and effect of adrenaline and Acetylcholine in vivo. |

| | |
|---|---|
| 3. | Study of retrocerebral complex of the cockroach. |
| 4. | Gonadectomy, Pancreatectomy, Adrenalectomy ,Thyroidectomy in rat/mouse |
| 5. | Effect of insulin on blood sugar, hepatic and muscle glycogen of the rat/human. |
| 6. | Estimation of thyroxine from human blood. |
| 7. | Determination of Acetylcholine esterase. |

**Section –I: ZOO: 4204 Biological Techniques(Any 10)**

| Sr. No. | Name of the Practical |
|---|---|
| 1. | Determination of λ-max for tyrosine and hemoglobin using UV/Visible spectrophotometer. |
| 2. | Separation of amino acids by TLC. |
| 3. | Separation of proteins by SDS-PAGE and analysis by gel documentation system. |
| 4. | Study isozymes by in-gel assays (zymogram). |
| 5. | Enzyme purification by Ion- Exchange Chromatography. |
| 6. | Perform primary animal cell culture and viable cell count. |
| 7. | Immobilization of amylase by enzyme immobilization technique. |
| 8. | Quantification of a protein Enzyme Linked Immunosorbent Assay. |
| 9. | Detection of protein by Western Blotting. |
| 10. | DNA amplification by Polymerase Chain Reaction. |
| 11. | Localization of proteins by immuno-histochemistry. |
| 12. | Introduction to databases and sequence alignment by BLASTA and FASTA. |
| 13. | Phase Contrast and Fluorescence Microscopy. |
| 14. | In situ detection of different enzymes |

**Course Articulation Matrix of ZOO: 4206: Zoology Practical-IV**
**Weightage: 1: Partially related, 2: Moderately related, 3: Strongly related**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 |
|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO2** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO3** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO4** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO5** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO6** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |
| **CO7** | 3 | 3 | 2 | 3 | 3 | 2 | 2 | 3 | 3 |

**PO1: Disciplinary Knowledge:**
All of the COs are directly mapped to PO1. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are directly address PO1 by requiring knowledge of specific physiological, neurobiological, and endocrinological concepts applied to diverse animal groups.

**PO2: Critical Thinking and Problem Solving:**
All of the COs are directly mapped to PO2. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are designing and executing experiments (CO3, CO4, CO5), analyzing data and interpreting results in the context of physiological principles (CO1, CO2, CO3, CO5, CO6, CO7), troubleshooting technical issues (CO3, CO5), and drawing conclusions about adaptations and regulatory mechanisms (CO1, CO2, CO5, CO6, CO7) all require critical thinking and problem-solving skills.

**PO3: Social Competence:**
All of the COs are directly mapped to PO3. All COs showing limited direct address. However, collaborating during experiments, discussing results, and preparing group reports could indirectly address communication and collaborative skills.

**PO4: Research-related skills and Scientific temper:**
All of the COs are directly mapped to PO4. For example CO1, CO2, CO3, CO4, CO5, CO6 & CO7 are applying learned techniques to investigate specific research questions (CO1, CO2, CO3, CO5, CO6), maintaining accurate lab records and data analysis (CO3, CO4, CO5, CO6), critically evaluating results and drawing objective conclusions (CO1, CO2, CO3, CO5, CO6, CO7) all contribute to research skills and scientific reasoning.

**PO5: Trans-disciplinary knowledge:**
All of the COs are directly mapped to PO5. For example CO1, CO2, CO3, CO5, CO6 & CO7 are relating physiological adaptations to environmental factors (CO1, CO2, CO5), connecting hormonal regulation to metabolic processes (CO3, CO4), comparing neural and hormonal control mechanisms across animal groups (CO5, CO6), and integrating biochemical analysis with histological observations (CO3, CO6, CO7) showcase trans-disciplinary thinking.

**PO6: Personal and professional competence:**
All of the COs are directly mapped to PO6. For example CO1, CO2, CO3, CO5, CO6 & CO7 are following safety protocols meticulously in practical sessions (CO3, CO5), independently performing complex procedures with precision (CO3, CO5), managing time effectively during experiments (CO3, CO5), and documenting results clearly and concisely (CO3, CO5, CO6, CO7) all require attention to detail, organization, and communication skills, contributing to PO6.

**PO7: Effective Citizenship and Ethics:**
All of the COs are directly mapped to PO7. All COs showing limited direct address. However, discussing the ethical implications of animal research, responsible treatment of animal models, and potential environmental concerns of lab reagents could indirectly touch on PO7.

**PO8: Environment and Sustainability:**
All of the COs are directly mapped to PO8. All COs showing limited direct address. However, emphasizing efficient reagent use, minimizing waste generation, and proper disposal of chemicals could indirectly address PO8.

**PO9: Self-directed and Life-long learning:**
All of the COs are directly mapped to PO9. For example CO1, CO2, CO3, CO5, CO6 & CO7 are Independently troubleshooting technical issues (CO3, CO5), adapting protocols to new research questions (CO3, CO5, CO6), critically evaluating and updating experimental approaches based on new findings (CO1, CO2, CO3, CO5, CO6, CO7) all foster independent learning and a willingness to adapt to new knowledge and techniques, encouraging PO9 skills.