PERIYAR UNIVERSITY

Periyar Palkalai Nagar, Salem-636011
(Reaccredited with 'A' Grade by the NAAC)

DEPARTMENT OF ZOOLOGY

M.Sc. DEGREE

ZOOLOGY

[Choice Based Credit System (CBCS)]

OBE REGULATIONS AND SYLLABUS

(Effective from the academic year 2020-2021 and thereafter)

M. Sc. ZOOLOGY

OBE REGULATIONS AND SYLLABUS

(With effect from the academic year 2020-2021 onwards)

1. Preamble

Department of Zoology was started in the year 2012 with M.Sc., M.Phil., and Ph.D. courses. This Department strives to create a suitable environment that enables teaching and research to attain high levels of excellence (through Publications and Patents) and in which its members can achieve their full potential right from Molecular Cell Physiology to understanding and targeting diseases like cancer and vector borne diseases, impact of climate change on insect diversity and bat behavior, Cultivation to commercialization of earthworms etc. Zoology is central to our understanding of the world. Zoologists seek to discover the fundamental principles that pinpoint animal life focusing on the diversity, function and evolution of animals and thus providing the scientific basis for our knowledge regarding the life style, physiology, diseases and their curative measure in the natural environment by conducting research in insects to mammalian cells.

2. General Graduate Attributes

By studying this programme students get state of the art knowledge about the Zoology and also the opportunities available by studying this course. Student get the aptitude for most of the job oriented course opportunities as well as ability to get success in various competitive exams such as TNPSC, UPSC and Indian forest service etc.

3. Programme Specific Qualification Attributes

By studying this programme the students get the eligibility and capability to clear SET and CSIR NET in Zoology and get eligibility to become Assistant Professors in Zoology as well as NET qualified research scholars. The students also become entrepreneurs and develop their own business and give employment to others.

- **Knowledge and understanding level (K1 and K2)**

  This course imparts knowledge which will be helpful to clear the competitive examinations in the field of Zoology. Students can understand the nature, physiology, biochemical and evolutionary aspects of all animals.

- **Application level (K3)**

  On completion of this course students can start the clinical and diagnostic labs in the field of biomedicine. They will also be capable of opening sericulture, apiculture and aquaculture industries.

- **Analytical level (K4)**

  Students can analyze each and every aspects of pathophysiology and biochemical reaction in animals including human being.

- **Evaluation capability level (K5)**

  Students can evaluate environmental conditions, animal metabolism, and human pathological conditions.

- **Scientific or synthesis level (K6)**

  By studying this course they can develop new drugs and patenting skills. They can also develop new hybrids using genetic engineering.

4. Vision

This Department strives to create a suitable an environment that enables teaching and research to attain high levels of excellence (through Publications and Patents) and in which its members can achieve their full potential right from Molecular Cell Physiology to understanding and targeting diseases like cancer and vector borne diseases, impact of climate change on insect diversity and bat behavior, Cultivation to commercialization of earthworms etc. In addition to the routine work, the Faculties actively engaging in research and also have collaboration with other Universities/ Research Institutions at national as well as International level. So far the Department of Zoology received more than a Crore of Rupees as research grant from various funding agencies like DST, UGC etc.

5. Programme Objectives and Outcomes

Spelt the PEOs (Programme Educational Objectives), Programme Specific Objectives (PSOs) and Programme Outcomes (POs)

Programme Educational Objectives

- To train our stakeholders to transform their theoretical knowledge into practical for the benefit of our society.

Programme Specific Objectives

- To motivate our stake holders to adopt fundamental mathematical tools (statistics) and physical Principles (physics, chemistry) to the analysis of relevant biological situations.

- The outgoing students must be talented to identify the major groups of organisms (invertebrates and chordates) with an emphasis on animals and be able to classify them within a phylogenetic framework (Evolution).

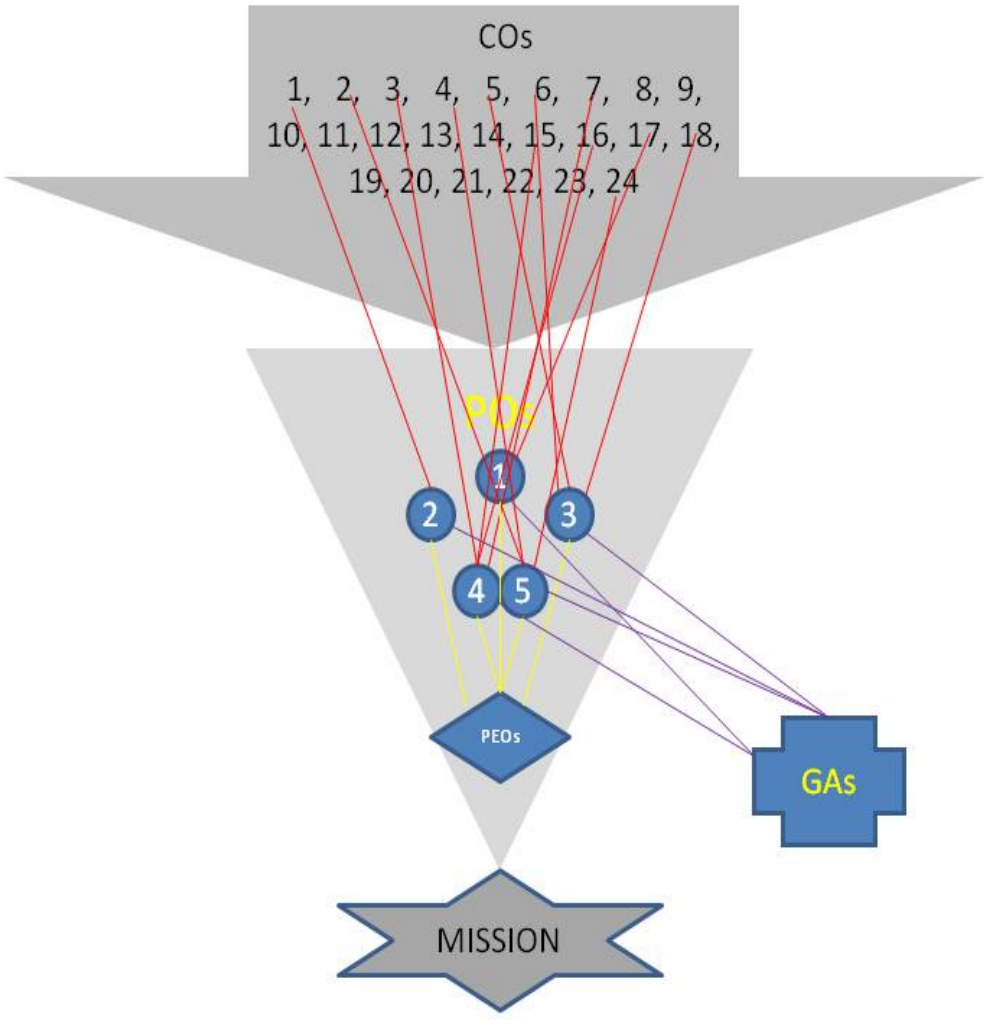
- Students will be able to compare and contrast the characteristics of animals that differentiate them from other forms of life (Comparative Biology).

- Our Stake holders would be clever to explain how organisms function at the level of the gene, genome, cell, tissue (Genetics, Cell Biology, Molecular Biology), organ and organ-system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behaviour of different forms of animals.

- To develop our students to apply their scientific knowledge to formulate testable hypotheses, gathering data that spell out these hypotheses, and analyzing those data to assess the degree to which their scientific work supports their society.

Outcome of the Programme

- Zoology program offered by Periyar University will mould our students to transform their theoretical knowledge into practical for the benefit of our Society by promoting agriculture and health care products. They will be the best academician cum Academic advisors for other institution. Our stake holders will get an opportunity to serve for our Government as Zoologist at ZSI, Entomologist in ICAR institutes, Aqua-culturist, Sericulture Specialist as an entrepreneur. There is an opportunity for our young minds to serve as conservators, Educators as teacher, professors etc.



Mission is the Programme Specific Objectives, GAs – Graduate attributes (general)

6. Candidate's eligibility for admission

Candidates who have qualified B.Sc., Zoology / Animal Science / Any other Degree related to Zoology / Life Sciences approved by the Syndicate of Periyar University, Salem.

7. Duration of the programme.

The duration of the M.Sc. Zoology Course shall be over a period of **Two Years** from the commencement of the course. A student shall obtain the M.Sc. Degree in Zoology if he/she has registered, undergone and secured the required minimum credits for all the Core and Elective courses and completed the Project Work / Dissertation within the stipulated time.

8. **CBCS- Structure of the Programme**

The programme structure comprises of two parts.

Course Component	No. of Courses	Hours of Learning	Marks	Credits
Part A (Credit Courses)				
Core Courses	13	936 (72hrs per course)	1300	52
Elective Courses	3	216 (72hrs per course)	300	12
Supportive Courses	2	108 (54hrs per course)	200	6
Lab Course	3	324 (108hrs per course)	300	9
Research	1	468 (26hrs per week)	200	12
Field visit	1	-	50	2
Soft skill development	1	36 (36hrs per course)	100	2
Online Courses (SWYAM)	2	-	100	4
Total	26	2088	2550	99
Part B (Self-Learning Credit Courses)				
Industry oriented course (Sericulture)	1	36 (36hrs per course)	100	2
Total	27	2160	2650	103
Value added Courses (Certificate will be issued separately)*				
Vermitechnology	1	36	100	1
PCR Technology	1	36	100	1
Add-on Courses (Certificate will be issued separately)*				
Ornithology	1	36	100	1

***Students choice to earn extra credits**

9. Curriculum structure for each semester as per your courses alignment

Core Paper-01 **Paper Code: 20ZOOC01**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

INVERTEBRATES

Course objectives:

- The students will classify the invertebrates upto order level.
- Understand the feeding and respiratory mechanisms in invertebrates.
- Learn the mechanism of chemical coordination and reproduction in invertebrates.

Course outcome:

At the end of the semester, students will be able to

- Classify invertebrates based on their morphology.
- Know the feeding mechanisms of invertebrates.
- Get the knowledge about chemical coordination and reproduction in invertebrates.

UNIT I: General Classification of invertebrates upto order level. Locomotion: Amoeboid, Flagella and Ciliary movement in protozoa. Locomotion in Annelida and Echinodermata.

UNIT II: Nutrition: Nutrition in Protozoan, Sponges, Coelenterates and Platyhelminthes - Filter Feeding in Polychaetes and Mollusca. **Respiration:** Respiratory organs – Gills, gill book, book lungs, parapodia, trachea, water vascular system with reference to respiration.

UNIT III: **Excretion:** Excretory organs and excretory products in invertebrates. **Circulatory system** - Circulation in Invertebrates – open and closed system. **Receptors:** Mechano reception – Chemoreception – Photoreception.

UNIT IV: Nervous System:- Primitive types - Coelenterates, Echinoderms and Hemichordates. Advanced types - Metameric nervous system-Giant nerve fibres- Molluscan nervous system-Nervous system and Learning in Cephalopods. Chemical co-ordination - neruohumors, neruohormones, endocrine regulation of moulting in crustaceans and insects, pheromones and allelochemicals.

UNIT V: Chemical Co-ordination: Hormones and neurohormones -Endocrine regulation in annelids, crustaceans, insects, and Molluscs -Pheromones and Allelochemicals. **Reproduction:** Asexual reproduction in Protozoans and Polychaetes. Unity in the early development of Metazoa- Protostomia and Deuterostomia. Phylogeny of invertebrates.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Develop skills in Taxonomy	✓	✓	✓	✓	
• Understand Physiology of Invertebrates	✓	✓	✓	✓	
• Learn the interaction between invertebrates and its ecosystem	✓	✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters	Hours of Instruction
INVERTEBRATES			
I	General Classification & Locomotion	K1, K2	14.4
II	Nutrition & Respiration	K1, K2	14.4
III	Excretion, Circulation and receptors	K1, K2	14.4
IV	Nervous System	K1, K2	14.4
V	Chemical Co-ordination and Reproduction	K1, K2, K3	14.4

REFERENCE BOOKS

1. Veer Bala Rastogi (2017) Invertebrate Zoology, Kedar Nath Ram Nath,
2. Kotpal R.L (2014), Modern Text Book of Zoology – Invertebrates, (2016 Ed) Rastogi Publications - Meerut
3. Robert D. Barnes (2006) Invertebrate Zoology, 7th Edition
4. Barrington E J W (2012) Invertebrate Structure and Function, (2nd Ed) Affiliated East-West Press Pvt. Ltd. New Delhi
5. Pechenik J.A. (2005) Biology of The Invertebrates Mc Graw Hill, India

Core Paper-02 **Paper Code: 20ZOOC02**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

CHORDATES

Course objectives:

- Motivate the students to learn the classification of chordates.
- Facilitate the students to know about the salient features of fishes and reptiles.
- To make the students to understand the adaptations in aves and mammals.

Course outcome:

At the end of the semester, students will be able to

- Classify chordates based on their morphology.
- Differentiate fishes and amphibians based on the morphology.
- Enumerate the adaptations of birds and mammals for terrestrial life.

UNIT I

Origin of Chordates and classification of Prochordates: Geological time scale, Origin of chordates, Vertebrate relationships and basic structure.

UNIT II

Type study: *Amphioxus.* **Pisces:** General characters and outline classification upto orders with suitable examples. Type study: Shark. **Amphibia:** Characters and classification of Amphibia up to order level. Origin of Amphibia, External characters of Frog. Biology and adaptive features of Anura, Urodela and Apoda. Parental care in Amphibia.

UNIT III

Reptilia: General characters and outline classification up to orders with suitable examples of biological interest. Skull in Reptilia. Morphology of *Calotes*. Origin and adaptive radiation in Reptilia – Extinct Reptiles. Identification and study of Poisonous and non-poisonous snakes of India.

UNIT IV

Aves: General characters and outline classification up to orders with suitable examples of biological interest. Type study: Pigeon. *Arachaeopteryx*, Significance of *Archaeopteryx*, Migratory Birds.

UNIT V

Mammalia: General characters and outline classification up to orders with suitable examples of biological interest. Prototheria, Metatheria and Eutheria- Type study: Rabbit. Importance of Marsupial Mammals. Exoskeleton structures of birds and mammals, Dentition in Mammals, Ruminant stomach in mammals and Echolocation in bats. Vertebrate Fossils: *Archaeopteryx* and Mesozoic mammals.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Understand taxonomy of Vertebrates	✓	✓	✓	✓	
• Understand physiology of Vertebrates	✓	✓	✓	✓	
• Know the Evolutionary relationship	✓	✓	✓	✓	
• Awareness on poisonous and non-poisonous snakes	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Origin of Chordates and classification of Prochordates	K1, K2	14.4
II	Pisces & Amphibia	K1, K2	14.4
III	Reptilia	K1, K2	14.4
IV	Aves	K1, K2	14.4
V	Mammalia	K1, K2	14.4

Reference books:

1. Kotpal, R.L. (2015). Modern Textbook of Zoology Vertebrates. Fifth Edition, Rastogi Publications, Meerut.
2. Jordan, E.L. and Verma, P.S. (2013). Chordate Zoology. Fourteenth Edition, S. Chand & Company, New Delhi.
3. Prasad, S.N. and Kashyap, V. (2012). A Textbook of Vertebrate Zoology. Fourteenth Edition, New Age International Pvt., Limited.
4. F. Harvey Pough, Christine M. Janis, John B. Heiser (2012), Vertebrate Life (9th Edition) Pearson Publisher
5. Ekambaranatha Ayyar, M. and Ananthakrishnan, T.N. (2003). A Manual of Zoology, Part-II (Chordata). Viswanathan Printers and Publishers, Chennai.
6. Kent, G.C. and Carr, R.K. (2001). Comparative Anatomy of the Vertebrates. Ninth Editilon, McGraw Hill Book Company.
7. Libbie Henrietta Hyman, 1992, Hyman's Comparative Vertebrate Anatomy, University of Chicago Press
8. J. Z. Young, Marion Nixon (1981)The Life of Vertebrates, Oxford University Press.
9. A.J. Waterman (1971),Chordate Structure and Function, Collier Macmillan Ltd

Core Paper: 03 **Paper Code: 20ZOOC03**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

THE CELL

Course objectives:

- To enable the students to gain basic and comprehensive knowledge in the multidisciplinary science of eukaryotic cell biology.
- To develop in-depth knowledge on molecular basis of cell functions.

Course outcome:

At the end of the semester, students will be able to

- Develop basic knowledge and skills in cell and molecular biology and become aware of the complexity and harmony of the cell.
- Understand how the study of cell biology has resulted in medical advance.

UNIT - I

Discovery of cell: Cell theory, Basic structure of prokaryotic and eukaryotic cell, Cell Cycle and regulations. Cell division: mitosis- Stages and Significance. Meiosis -Stages and their significance, Formation of Synaptonemal Complex - Importance of Meiosis in evolution of sexual reproduction in animals and Nondisjunction.

UNIT - II

Ultra-structure, types and functions of Plasma membrane – Fluid Mosaic model theory; Ribosome and Golgi bodies, Lysosome, Endoplasmic reticulum. Mitochondria: ultrastructure and functions. Micro bodies peroxisomes and glyoxisomes.

UNIT – III

Nucleus: ultrastructure of nuclear membrane, Nucleolus, Nucleoplasm and Chromatin fibres, Microtubules, microfilaments – Cilia and Flagella. Signal Transduction Pathways: organization of cell signals and their receptors. Ion channel coupled receptors – secondary messengers. Amplifiers, Integrators and signal hypothesis.

UNIT – IV

Nucleic Acid: DNA as genetic material (direct and indirect evidences) – Structure and types of DNA and RNA. Eukaryotic Chromosome: Chromosome structure based classification. Mutations: Mutagens-physical, chemical and biological agents – mutation types –molecular basis of spontaneous and induced mutation. Mutagenesis testing: AMES test.

UNIT - V

DNA replication – semi conservative and rolling circle models. Enzymes involved in DNA replication: types and their functions. Transcription and Translation in eukaryotes: RNA polymerase – types, properties and functions–Transcription process in Eukaryotes – RNA processing, capping, polyadenylation, splicing mechanism. Protein Synthesis: Translation and post translational modifications and their biological importance. Mechanism of cell aging and senescence. Comparison of Cell death: Necrotic and apoptotic cells.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Develop skills in cell biology • To gain knowledge and practical skill related to clinical laboratories • To establish knowledge on molecular biology		✓ ✓ ✓	✓ ✓ ✓	✓ ✓ ✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Discovery of cell & Cell division	K1, K2, K3, K5	14.4
II	Cell organelles	K1, K2, K3, K5	14.4
III	Nucleus & Signal Transduction Pathways	K1, K2, K3, K5	14.4
IV	Nucleic Acid & Mutations	K1, K2, K3, K6	14.4
V	DNA replication & Protein Synthesis	K1, K2, K3, K6	14.4

REFERENCE BOOKS:

1. Cooper, G.M.2016. The Cell – A Molecular Biological Approaches. ASM Press, Washington.

2. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2015) Essential Cell Biology. Garland Science, New York

3. De Robertis EDP and De Robertis EMF (2011) Cell and Molecular Biology. Lippincott Williams and Wilkins, USA.

4. Gupta PK (2014) Cell and Molecular Biology. Rastogi Publications, Meerut.

5. Karp G (2017) Cell and Molecular Biology: Concepts and Experiments. 6th edition, John Wiley and Sons Ltd. New York.

6. Lewin B (2016) Genes XIII Oxford University Press, Oxford.

7. Walker JM and Gingold EB (2013) Molecular Biology and Biotechnology. Panima University Press, Oxford Publishing Co., New Delhi.

8. Thorpe NO (2000) Cell Biology, John Wiley and Sons, New York.

9. Turner PC McLennan AG Bates AD and White MRH (2007) Instant Notes Molecular Biology. Viva Books Pvt. Ltd., New Delhi.

10. Thomas Pollard, William Earnshaw, Jennifer Lippincottt Schwartz,Graham Johnson, (2017) Cell Biology, 3rd Edition,Elsevier Pupblishing, USA,

Core Paper: 04 **Paper Code: 20ZOOC04**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

BIOCHEMISTRY

Course objectives:

- To enable the students to learn the biological phenomena at the molecular level.
- To provide a basic and advanced understanding of the principles of Biochemistry.
- To acquire knowledge on the fundamental chemical principles that governs complex biological systems.

Course outcome:

At the end of the semester, students will be able to
- Acquire a concrete foundation in biological chemistry.
- Get job opportunity in Biochemical Industries, Clinical Laboratories, Research and Development Laboratories for higher studies.

UNIT – I

Atoms: Chemical Composition of living matter. Biological importance of water. Buffers and its Physiological properties. Handerson and Hasselbach's Equation and pKa value determination. Classification, structure and function of carbohydrates. Carbohydrate metabolism and metabolic disorder: Diabetes and their biomedical significance.

UNIT II

Amino acids: Structure, classification and physicochemical properties of amino acids, Essential amino acids, glycogenic and ketogenic amino acids. **Proteins:** Classification and properties of proteins. Levels of structure in protein architecture. **Enzymes:** Types of Enzymes. Structure of Lysozyme, mechanism of enzyme action, enzyme kinetics, enzyme inhibitors, coenzymes. Inborn errors of metabolism.

UNIT III

Lipids: Structure and Classification, Oxidation of fatty acids, ketosis, biosynthesis of fatty acids, triglycerides, Cholesterol physiology & function, Cholesterol biosynthesis and Beta oxidation of fatty acids. Biomedical importance of very-low-density lipoproteins (VLDL), intermediate-density lipoproteins (IDL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL). Obesity: Causes and Preventive measures.

UNIT IV

Porphyrins: Hemoglobin synthesis and Sickle cell anemia. Nucleoside and nucleotide. **Nucleic acids:** Free nucleotides – structure, properties and functions of RNA and DNA. Synthesis and degradation of purine and pyrimidine (De novo and salvage pathways). Syndromes associated with nucleic acid metabolism: Aicardi-Goutières syndrome (AGS), Lesch-Nyhan syndrome and GOUT Disease.

UNIT V

Signal transduction: Hormones and their receptors, steroid hormone receptor and gene action. Peptide hormone receptor (cell surface receptors), signaling through G-protein coupled receptors, signal transduction pathways, cAMP, cGMP, phosphatidyl inositol and calcium as second messengers, regulation of signaling pathways.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Priority is given to our stake holders in clinical laboratories		✓	✓	✓	
• Students can understand biochemical reactions taking place in our body		✓	✓	✓	
• Can develop private R&D laboratories to train the students		✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Atoms & Carbohydrates	K1, K2, K3, K4	14.4
II	Amino acids, Proteins & Enzymes	K1, K2, K3, K4, K5	14.4
III	Lipids	K1, K2, K3, K4, K5	14.4
IV	Porphyrins &Nucleic acids	K1, K2, K3	14.4
V	Signal transduction	K1, K2, K3, K4, K5, K6	14.4

REFERENCE BOOKS

1 Murray, R. K., Granner, D. K., Mayes, P. A., Rodwell, V. W. (2017) Harper's Biochemistry. Prentice Hall International Inc.

2 Lehninger, A. L., Nelson, D. K., and Cox, M. M. (2015) Principles of Biochemistry. CBS Publishers and distributors, New Delhi.

3 Stryer, L. (2016) Biochemistry. W. H. Freeman and Company, New York.

4 Voet.D. Judith, G. Voet, Charlotte W. Pratt. (2014) Fundamentals of Biochemistry, John Wiley& Sons Inc. New York.

5 Satyanarayanan, U (2015). Essentials of Biochemistry, Uppala Author – Publisher Interlinks, Vijayawada.

Core Paper: 05 **Paper Code: 20ZOOC05**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

PRINCIPLES OF GENETICS

Course objectives:

- To understand the concepts and applications of genetics.
- To learn on the quantification of heritable traits.
- To know the role of genes in human health and development.

Course outcome:

On successful completion of this course, the student will be:

- Eligible to get job opportunities in R&D Laboratories, Biopharmaceutical Companies and Clinical Laboratories.

UNIT I

Mendelian principles: Dominance, segregation, independent assortment, deviation from Mendelian inheritance. Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, linkage and crossing over, X linkage, X limited, and X influenced characters. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers.

UNIT II

Extra chromosomal inheritance: Inheritance of mitochondrial genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes. Human genetics: Pedigree analysis, lod score for linkage testing, karyotypes, genetic disorders.

UNIT III

Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.

UNIT IV

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Holiday Model, Homologous and non-homologous recombination, including transposition, site-specific recombination.

UNIT V

Principles and applications of prenatal diagnosis – Chorionic villus sampling and Amniocentesis. Karyotyping – Detection of Syndromes – Chromosomal micro-dissection, DNA Finger Printing and Fluorescent *in situ* Hybridization (FISH). DNA sequencing, HGP – merits and demerits, RFLP and AFLP.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Promote to get jobs in R&D laboratories of various sectors	✓	✓	✓	✓	
• Gain knowledge about the genes and their functions	✓	✓	✓	✓	
• Genetic disorders and diseases can be predicted by the students using pedigree analysis	✓	✓	✓	✓	
• Develop skills to modify the genetic system of an organism	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Mendelian principles	K1, K2	14.4
II	Extra chromosomal inheritance & Microbial genetics	K1, K2	14.4
III	Quantitative genetics & Mutation	K1, K2, K3, K4, K5	14.4
IV	Structural and numerical alterations of chromosomes	K1, K2, K3, K4, K5	14.4
V	Principles and applications of prenatal diagnosis	K1, K2, K3, K4, K5, K6	14.4

REFERENCE BOOKS:

1) Camarin, R.H. 2017. Principles of Genetics. 7th Edition, McGraw Hill Education.

2) Watson, J.D. and Tania, A.B. 2017. Molecular Biology of the Gene. 7th Edition, Pearson Education.

3) Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. 2017. Lewin's Genes XII. 12th Revised Edition, Jones and Bartlett Publishers.

4) Snustad, D.P. and Simmons, M.J. 2015. Principles of Genetics. 7th Edition, John Wiley and Sons.

5) Strickberger M.W. 2015. Genetics. 3rd Edition, Prentice India.

6) Primrose, S.B. and Twyman, R. 2006. Principles of Gene Manipulation and Genomics. 7th Edition, Blackwell Publishing Company.

Core Practical Paper: 01 **Paper Code: 20ZOOP01**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

LAB COURSE-I

Course objectives:

- To understand the working principles and applications
- To learn how to quantify the biochemical substances and heritable traits.
- To know the role of fauna in and around our ecosystem.

Course outcome:

On successful completion of this skill-based course, the student will be eligible to get job opportunities in R&D Laboratories, Biopharmaceutical Companies and Clinical Laboratories and also be selected as fauna conservators

Core I & II Invertebrates and Chordates

1. Structure and function of Major Mammalian Organs (Rat-heart, pancreas, liver, kidney and gonads) – Voucher Specimen
2. Spotters and Slides (For *Plasmodium* sp., Sponges, *Hydra,* Liver fluke, Tape worm, *Peripatus, skeleton of Human.*)
3. Survey of Insects in Periyar University Campus (Field Study)
4. Survey of Birds in Periyar University Campus (Field Study)
5. Identification of Migratory Birds

Core III Cell and Molecular Biology

1. Micrometry for cell measurement
2. Identification of different types of cells in blood
3. Observation of Mitosis (onion root tip)
4. Observation of Meiosis (Grasshopper – Voucher Specimen)
5. Cells of vital organs (Slides: Kidney, Liver, Spleen, Stomach, muscles, lung and colon)

Core IV Biochemistry

1. Estimation of Protein
2. Determination of glucose level in Blood
3. Effect of Temperature on salivary amylase activity
4. Identification of amino acids by paper chromatography
5. Spotters: Diabetes, Lesch-Nyhan syndrome and GOUT Disease

Core V Genetics

1. Observation of Mendelian traits Among Student Volunteers
2. Identification of Human Syndromes – Voucher Specimen

3. Study on polygenic inheritance – Voucher Specimen
4. Pedigree Analysis of Genetic Disorder (Hemophilia and Diabetes)
5. Genetic Counseling methods (Among Student Volunteers)

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Exclusively develop skills in cell biology, biochemistry, genetics and molecular taxonomy	✓	✓	✓	✓	
• Gain knowledge to work with biochemical and microbiological laboratories to predict diseases	✓	✓	✓	✓	✓
• Understand the histology of vital organs and their functions	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Invertebrates	K1, K2, K3, K6	21.6
II	Chordates	K1, K2, K3, K6	21.6
III	Cell and Molecular Biology	K1, K2, K3, K4, K5, K6	21.6
IV	Biochemistry	K1, K2, K3, K4, K5, K6	21.6
V	Genetics	K1, K2, K3, K4, K5, K6	21.6

REFERENCE BOOKS:

1. Plumer HT (2012) Practical : Biochemistry , Wiley Publication, India

2. Borah D (2012) Biotechnology Lab Practices, Global Academic Publisher, India.

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Elective Paper: 01 **Paper Code: 20ZOOE01**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

MICROBIOLOGY

Course objectives:

- To provide students with the latest information in microbiological methods.
- To provide advanced knowledge, understanding, and critical judgment about the profession in microbiology.

Course outcome:

On successful completion of this course, the student will be:

- Able to recall the relationship of infections to symptoms, relapse and the accompanying pathology.
- To develop a heightened sense of understanding in students about the microscopic world around them.

UNIT I:

History and Scope of Microbiology- Wittaker's Five Kingdom concept- General features of prokaryotes. Morphology and ultra-structure of viruses. Mycology: Classification of biomedically important fungal species.

UNIT II:

Culture and Characterization: Isolation and identification of bacteria. Techniques of pure culture methods. Phases of growth. Methods of sterilization and disinfection –. Staining: Simple and differential staining; Gram staining; acid fast staining; endospore staining; capsule staining and flagella staining.

UNIT III:

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction. Microbial Genomics: Gemone project of *Escherichia coli* and *Yeast.* Metagenomics concepts and Significance. Microbial control – Physical and chemical agents

UNIT IV:

Host parasite interaction: Principles of Disease and Epidemiology , Microbial Mechanisms of Pathogenicity Innate Immunity: Nonspecific Defenses of the Host Adaptive Immunity: Specific Defenses of the Host

UNIT V:

Industrial Microbiology: Microbial fermentation Microbial production of Antibiotics: penicillin, streptomycin, Vaccines - genetic recombinant vaccines. Bioremediation- Principles and applications.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Develop skills in microbiology		✓	✓	✓	
• To gain knowledge and practical skill related to clinical laboratories		✓	✓	✓	
• To establish knowledge on pathogenic microbes		✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	History and Scope & Mycology	K1, K2, K3	14.4
II	Culture and Characterization	K1, K2, K3, K4, K5, K6	14.4
III	Microbial genetics	K1, K2	14.4
IV	Host parasite interaction	K1, K2, K3, K4, K5, K6	14.4
V	Industrial Microbiology	K1, K2, K3, K4, K5, K6	14.4

REFERENCE BOOKS:

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2. Dubey RC and Maheswari DK (2014) Textbook of Microbiology. S. Chand and Co.

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Elective Paper: 02 **Paper Code: 20ZOOE02**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

SOFT SKILL DEVELOPMENT

Course objectives:

- To establish positive attitude.
- To learn to understand the interpersonal skills.
- To develop skill-oriented employability

Course outcome:

On successful completion of this course, the student will be get motivation to assess the interpersonal skill and will provide job opportunity / counselling to others.

UNIT I
Capacity Building: Self-awareness - building self - esteem - importance of having a strong self– esteem – developing positive attitude -. Anchoring on principles: Universal principles and values – forming & inculcating values.

UNIT II
Interpersonal skills: Trust-trustworthiness - interpersonal communication – art of listening, reading and writing – art of writing e-mails and e-mail etiquettes – building relationship-networking.

UNIT III
Corporate skills: Vision, mission and goals: Concepts, vision setting, goal setting- goals for roles. Group goal – concept of synergy – team building – group skills.

UNIT IV
Management skills: Developing Body Language – Practicing etiquette and mannerism – Stress Management –Time Management: Important and urgent activities - time management to move towards life vision.

UNIT: V
Employability Skills: Writing Resume / CV – interview skills – Group Discussion – Mock Interview – Mock GD – Career Planning.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To become a councilor	✓	✓	✓	✓	
• To become a consultant in corporate companies	✓	✓	✓	✓	
• To become a journalist	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Capacity Building	K1, K2, K3, K4, K5	14.4
II	Interpersonal skills	K1, K2, K3, K4, K5	14.4
III	Corporate skills	K1, K2, K3, K4, K5	14.4
IV	Management skills	K1, K2, K3, K4, K5	14.4
V	Employability skills	K1, K2, K3, K4, K5	14.4

REFERENCE BOOKS:

1 Alex K. (2012) Soft Skills – Know Yourself & Know the World, S. Chand & Company Ltd. New Delhi

2 Meena K. Ayothi V. (2013). A Book on Development of Soft Skills (Soft Skills: A Road Map to Success), P.R. Publishers & Distributors, Trichy.

3 Francis Thamburaj S.J. (2009). Communication soft skills for Professional Excellence, 1st Ed., Grace Publishers.

4 Rathan Reddy B. (2005). Team Development and Leadership,Jaico Publishing House, Mumbai.

Core Paper: 06 **Paper Code: 20ZOOC06**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ANIMAL PHYSIOLOGY

Course Objectives:

- To impart the functional aspects of human physiological systems.
- To learn on the physiology of sensory organs.
- To understand circulatory and myocardial functions.

Course Outcome:

- Students will get opportunity to serve as Lab Technician in Paramedical Institutes.
- Students will get a chance to enter higher education like Ph.D. Programme.

UNIT I

Homeostasis in animals- Thermoregulation**:** Temperature compensation in poikilotherms, Temperature Regulation in homeotherms, Physical, chemical and neural regulation. **Osmotic and ionic regulation**: Response to hyperosmotic and hyposmotic media with reference to fishes. **Stress and adaptations**: Adaptations to pressure - High altitude.

UNIT II

Respiration- Comparative physiology of respiration in relation to different habitats- Aquatic habitat: Fishes, Terrestrial: Human respiratory system, Aerial: Birds and Insects, neural and chemical regulation of respiration.

UNIT III

Circulation and Excretion:
Comparative anatomy of heart structure, myogenic heart, cardiac cycle, heart as a pump, blood pressure, blood volume regulation, neural regulation, ECG - its principle and significance. Comparative physiology of excretion in relation to different habitats, kidney - urine formation, concentration, elimination and regulation of water balance.

UNIT IV

Muscle: Types of Muscles- Striated and non-striated, voluntary and involuntary, Ultra structure of muscle fiber, Chemistry and Molecular mechanism of muscular contraction. Neuromuscular coordination, Muscle fatigue and muscle twitch

UNIT V

Nervous system and sensory physiology:
Gross anatomy of brain and spinal cord, Structure of neuron, nerve conduction, interneuron transmission, Synoptic theories, Central and peripheral nervous system - **Receptors:** Chemoreception- Chemical senses, taste and smell, Phonoreception – Physiology of hearing, Photoreception - Photochemistry of vision.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Able to draw and illustrate human organ systems	✓	✓	✓	✓	
• Understand the functions of endocrine glands and hormones	✓	✓	✓	✓	
• Explain the human circulatory system	✓	✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Homeostasis, Osmotic and regulation	K1, K2	14.4
II	Respiration	K1, K2	14.4
III	Circulation and Excretion	K1, K2	14.4
IV	Muscle Physiology	K1, K2	14.4
V	Nervous system and sensory physiology	K1, K2, K5	14.4

REFERENCE BOOKS

1 Eckert, Roger, Randall, D.J., Burggren, Warren, French, Kathleen. (2011) Eckert's Animal Physiology, Fifth Edition. W.H.Freeman & Co Ltd. USA

2 Gordon, M. S., Bartholomew, G. A., Grinnel, A. D., Jorgensen, C. B. White, F.N., (1971) Animal Function - Principles and Adaptations. Macmillan Co. London.

3 Hall, J. E (2015) Guyton and Hall Text Book of Medical Physiology. Thirteenth Edition, Elsevier Sander Publications, USA.

4 Ian Kay, (2006) Animal Physiology Pear Tree Press Ltd., Singapore.

5 Knut Schmidt-Nielsen, (2011).. Animal Physiology: Adaptation and Environment, Sixth Edition, Cambridge University Press, UK.

6 Moyes, C. D., and P. M. Sculte (2016) Principles of Animal Physiology, 2nd Edition, Pierson Education, India.

7 Prosser, C.L. and Brown (1985) Comparative Animal Physiology III Ed. W.B. Saunders Company, Philadelphia

8 Richard W. Hill, (2016). Animal Physiology. 4th Edition, Sinauer Associates, Inc. USA.

Core Paper: 07 **Paper Code: 20ZOOC07**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

DEVELOPMENTAL BIOLOGY

Course objectives:

- To motivate the students to learn the basic concepts of Developmental Biology.
- To facilitate students to learn the molecular perspective of fertilization.

Course outcome:

On successful completion of this course, the student will be Able to get an opportunity to work as a Lab Technician in fertility clinics and Gaining knowledge to fit themselves to do research in the topic of interest.

UNIT I

Basic concepts of development: Eggs and their types-Polarity, symmetry and chemo-differentiation of egg. Gamitogenesis: Spermatogenesis and Oogenesis. Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; Genes contributing to gonad development – Role of SF1, WT1, SRY, SOX 9 and other genes.

UNIT II

Role of maternal contribution in early embryogenesis – masked RNA. Molecular perspectives of fertilization: Recognition of egg and sperm, sperm attraction, acrosome reaction, species – specific recognition, cortical reaction, activation of egg metabolism, fusion of genetic material.

UNIT III

Totipotency and pleuripotency of cleavage blastula and gastrula and morphogenetic movements.Nnuclear transplantation experiments in amphibians – Embryonic stem cell and its application. Genes that pattern *Drosophila* body plan: morphogenetic gradients, cascades and signaling pathways in *Drosophila* development – Homeo box concept and its role.

UNIT IV

Cell-cell interaction, adhesion and communication – Organizer and induction: Spemann's classical experiment, molecules of Nieukoop center – activin, noggin, BMP4, Wnt, FGF and retinoic acid – chemistry and mechanism.Limb development in vertebrates.Post embryonic development – larval formation, metamorphosis,Environmental regulation of development.

UNIT V

Differentiation – definition, differentiation at tissue level - epithelio-mesenchymal interaction, differentiation at organ level – cyclopia and acephaly, role of Hox D gene, Hoxa gene. Concept of gene knock out, abnormal differentiation – teratoma and teratogens. Mechanism of Programmed cell death (Apoptosis).

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Understand the mechanism of fertilization	✓	✓	✓	✓	
• Draw the structure of sperm	✓	✓	✓	✓	
• Compare the reproductive system of vertebrates	✓	✓	✓	✓	
• Knowledge about the gastrulation of amphibian	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Basic concepts of development	K1, K2	14.4
II	Fertilization	K1, K2	14.4
III	Totipotency and pleuripotency & Stem cells	K1, K2, K3, K4, K5, K6	14.4
IV	Cell-cell interactions	K1, K2, K3, K4, K5	14.4
V	Differentiation & gene knock out	K1, K2, K3, K4, K5, K6	14.4

REFERENCE BOOKS

1. Frederick R Bailey (2018), Text-Book of Embryology, Forgotten Books.
2. Datta A. K. (2017), Essentials of Human Embryology (7th Ed.), Current Books International
3. Subhadra Devi V (2017), Inderbir Singh's Human Embryology (11th Revised Ed.), Jaypee Brothers Medical Publishers
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5. Scott F. Gilbert (2016), Developmental Biology (11th edition), Sinauer.
6. Sadler (2016), Langman's Medical Embryology (13th Ed.), Wolters Kluwer.
7. Tickle, Martinez Arias Wolpert (2015), Principles of Development 5th Ed) Oxford University Press.
8. Carlson (2013), Human Embryology and Developmental Biology (5th Ed), Elsevier Health – US
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10. Das N (2012), Fundamental Concepts of Developmental Biology, Affiliated East-West Press Pvt. Ltd. New Delhi.
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Core Paper: 08 **Paper Code: 20ZOOC08**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

EVOLUTION

Course Objectives:

- To enable the students to understand how living systems evolved.
- To understand the mechanism of evolutionary changes through adaptation, natural selection, speciation and the history of life.

Course Outcome:

On successful completion of this course, the student will be able to:

- Get jobs in Zoological Museum, Zoological Survey of India (ZSI), and Paleontological Institutes.
- Apply knowledge of evolution to the solution of problems facing the human population and in animal conservation.

UNIT – I

Introduction: Early ideas of evolution – Lamarckism, Neo-Lamarckism – Charles Darwin: The voyage on the Beagle – Neo-Darwinism – Species concepts – The Biological Species concept – A general theory of speciation and its impacts.

UNIT – II

Hardy-Weinberg equilibrium – The causes of evolution – Mutation and Gene flow with reference to Rates of evolutionary change; Genetic drift and Non-random breeding – Reproductive isolating mechanisms: Models of population growth – Variation in natural populations. Phenotypic variation: Polygenic traits.

UNIT – III

Natural selection I: Stabilizing, directional, and disruptive selection- Natural selection II: The general selection model- Group selection, kin selection, and sociobiology- Ecogeographic rules: Subspecies concepts- Clines and hybrid zones

UNIT – IV

Phenetics and cladistics- Tracing ancestor-descendant relationships- The molecular clock- Phyletic patterns and biogeography- Evolutionary trends and laws: Gradualism and punctuated equilibria- Adaptation and adaptive radiation with reference to convergent and divergent evolution.

UNIT – V

Ontogeny and phylogeny: Historical perspective; allometry and Species selection. Evolutionary innovations and the origin of higher taxa- Evolution of *Homo sapiens* and molecular biological and immunological evidences for evolution. Impact of DNA bar coding in modern Evolutionary studies.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Compare the different types of evolutionary theories	✓	✓	✓	✓	
• Gain knowledge about the human evolution	✓	✓	✓	✓	
• Able to differentiate sympatric and allopatric species	✓	✓	✓	✓	
• Knowledge about the fossilization	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Introduction & Species concepts	K1, K2	14.4
II	Hardy-Weinberg equilibrium	K1, K2	14.4
III	Natural selection	K1, K2	14.4
IV	Phenetics and cladistics	K1, K2	14.4
V	Ontogeny and phylogeny	K1, K2	14.4

REFERENCE BOOKS:

1. Cain, A. 2018. Animal Species and Their Evolution. Princeton University Press.
2. Parker, S. and Roberts, A. 2015. Evolution: The Whole Story. Thames and Hudson Publishers.
3. Hall, B.K. and Hallgrimsson, B. 2014. Strickberger's Evolution. Jones and Bartlett Publishers.
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5. Herron, J.C. and Freeman, S. 2013. Evolutionary Analysis. 5th Edition. Pearson Publication.
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7. Dobzhansky, T. 1970. Genetics of the evolutionary process, Columbia University Press.
8. Darwin, C. 1958. The Autobiography of Charles Darwin 1809-882., The Norton Library, New York.
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Core Paper: 09 **Paper Code: 20ZOOC09**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ANIMAL BEHAVIOUR AND ENDOCRINOLOGY

Course Objectives:

- To enable the students to impart knowledge about the different types of behaviour.
- To gain basic understanding about endocrinology.
- To know how the animals, communicate.

Course Outcome:

- Students will get knowledge about the different types of animal behaviour.
- They apply their knowledge to know the behavioural patterns of animals while doing research.
- Students gain knowledge about the endocrine glands and the diseases

Unit I

Introduction to animal behaviour- History of Animal behaviour- Karl Von Fritz, Tinbergen and Lorenz contribution- Methods for studying animal behaviour- Proximate and ultimate causation of behaviour- **Behavioural patterns**- Orientation, animal navigation and migration- Instinct Vs Learnt behaviour- Associative learning- Classical and Operant conditioning- Habituation, imprinting.

Unit II

Social behaviour and animal signalling- Altruism- Honey bee, Vampire bats- Hamilton's rule, Kin Selection-Group foraging and its advantages- Dispersion- migration- territoriality- Animal Communication in birds, bees and wild mammals- Warning colouration, mimicry and deception.

Unit III

Mating system- Sexual dimorphism- Male- Male competition- Female choice- Leks- Alternative mating tactics-satellite males- monogamy- Polyandry- Polygyny- Sperm competition- Parental care.

Unit IV

Pheromone Biology- Chemical Signals– Types and uses. Pheromones in invertebrates, Insect pheromones in pest management programme. Pheromones in vertebrates. Pheromone perception: Olfactory and Accessory olfactory systems in animals. Pheromones and reproductive behavior: Lee Boot effect, Vandenberg effect, Bruce effect. Mammalian Pheromones: Sources and types, mode of action in mammals, neuro-endocrine regulation of pheromone function. Role of Pheromones in animal behaviour. Biology of Human Pheromone communication.

Unit V

Endocrinology and Chronobiology- Basic mechanisms of hormone action- Neuroendocrine mechanism in insect growth and reproduction- Endocrine glands: Pituitary, Thyroid, Parathyroid and adrenal- Functions and disorders- **Biological rhythm**- Types and characteristics of biological rhythm- photic and non-photic zeitgebers, Entrainment and free running rhythm- short term and long-term rhythm- Circadian rhythm, Pace maker, Melatonin and clock genes.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Explain different types of learning	✓	✓	✓	✓	
• Developing skills for watching animal behaviour	✓	✓	✓	✓	
• Elucidate the theory of sexual selection	✓	✓	✓	✓	
• Knowledge on parental care in animals	✓	✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Introduction & Behavioural patterns	K1, K2	14.4
II	Social behaviour and animal signalling	K1, K2	14.4
III	Mating system	K1, K2	14.4
IV	Pheromone Biology	K1, K2, K6	14.4
V	Endocrinology and Chronobiology	K1, K2, K3, K4, K5, K6	14.4

REFERENCES

1 Alcock, J (2017) Animal Behavior: An Evolutionary Approach, Sinauer Associates, USA.

2 Breed, M.D., and J. Moore (2015) Animal Behavior, 2nd Edition, Academic Press, USA

3 Davies, N. B., Krebs, J.R and West (2012) An Introduction to Behavioural Ecology, Wiley- Blackwell Publication

4 Hadley, M., and J. Levine (2006) Endocrinology, Pearson 6th Edition, USA

5 Manning, A, and M. Dawkins (2012) An Introduction to Animal Behaviour, Cambridge University Press, London

6 Nelson, R. J., Krigsfeld, L. J (2016) An Introduction to Behavioral Endocrinology, 5th Edition, OUP, USA.

7 Turner, C.D. (2012) General Endocrinology, East-West Press Pvt. Ltd, New Delhi.

8 Wyatt, T.D. 2014. Pheromones and Animal Behaviour. Cambridge University Press, USA

9 Bruce, A. schutle, Thomas, E. and M.H. Ferkin, 2016. Chemical Signals in Vertebrates. Springer International Publishing. Switzerland.

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Core Practical Paper: 02 **Paper Code: 20ZOOP02**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

LAB COURSE-II

Course objectives:

- To have hands on experience in handling of hormone related disorders.
- To support to do experiments on animal physiology
- To learn how do we enhance the productivity in Fishery and Silk industries

Course outcome:

- This course work paves the way for bringing research outcome for the betterment of our society and promotes entrepreneurship.

1. Pregnancy testing for hcG in urine samples (from Volunteers)
2. Identification of thyroidism among the students (from Volunteers)
3. Effect of pH on opercular movement in fish
4. Effect of temperature on opercular movement in fish
5. Online Observations of impact of climate change on Biodiversity in India
6. Cultivation of Silkworm to assess the Larval and Pupal stages of silkworm
7. Identification of Endocrine glands in mammals (Voucher Specimen)
8. Identification of Endocrine glands in insect (Voucher Specimen)
9. Identification of Scent glands in mammals
10. Identification Pheromone glands in insects
11. Identification of Secondary sexual characters in Peacock
12. Identification of Homology among Fauna of Periyar University
13. Identification of Vestigial organs of human by Student Volunteers (own)
14. Case Study Report: Ants and plant interaction (Convergent Evolution)

SPOTTERS:

1. Typical structure of Neuron
2. Ultra-structure of Skeletal Muscles
3. Observation of 24, 48 and 72 Hour stages of Chick embryo
4. Blastula and Gastrula stages in Embryo
5. Photographs for tsunami effects in Tamil Nadu
6. Adaptive Radiation in Darwin Finches
7. Marine and freshwater prawns
8. Phylogenetic Tree
9. Pheromone trap
10. Pheromones and Animal behaviours

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Develop skills for dissecting animals	✓	✓	✓	✓	
• Draw the neuro-endocrine system in insects	✓	✓	✓	✓	
• Identify and explain about the stages of chick embryo	✓	✓	✓	✓	✓
• Able to identify blood groups and developing lab technician skills	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Animal Physiology	K1, K2, K6	21.6
II	Developmental Biology	K1, K2, K6	21.6
III	Evolution	K1, K2, K6	21.6
IV	Animal Behaviour	K1, K2, K6	21.6
V	Endocrinology	K1, K2, K6	21.6

REFERENCE BOOKS

1. Laura R. Keller, John H. Evans, Thomas C. S. Keller (1999) Experimental Developmental Biology: A Laboratory Manual, Academic Press.

2. Yolanda P. Cruz (1993) Laboratory Exercises in Developmental Biology, Academic Press.

3. Nigam SC, Nigam SC andOmkar (2006) Experimental Animal Physiology and Biochemistry, New Age International.

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Elective Paper: 03 **Paper Code: 20ZOOE03**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

VERMITECHNOLOGY

Course Objectives:

- To understand the concepts of vermiculture and vermicomposting.
- To understand the characteristics of earthworm species suitable for vermiculture and vermicomposting.
- To understand various applications of earthworms in organic solid waste management, soil fertility, and bioremediation.

Course Outcomes:

On successful completion of this course, the student will be able to understand the core concepts of vermiculture and vermicomposting and then involved in the entrepreneurship to promote agriculture. Successful students will apply vermitechnology in vermicomposting, soil fertility, and bioremediation processes and become an entrepreneur.

UNIT- I: Earthworm – morphology and anatomy – Biology of *Perionyx excavatus*. – Ecological grouping – Epigeic, Anecic and Endogeic species; Ecological role and economic importance of earthworms.

UNIT- II: Vermiculture – definition, scope and importance; Common species for culture; Environmental requirements; Culture methods – indoor and outdoor cultures – monoculture and polyculture. Different methods for setting-up of vermicomposting units.

UNIT- III: Applications of vermiculture – Vermicomposting – different methods of vermicomposting; use of vermicastings in organic farming/horticulture, earthworms for management of municipal organic solid wastes. Nutrient value of worm cast/vermicompost – Effect of vermicompost on plants.

UNIT- IV: Advantages of Vermitechnology – Marketing the products of vermiculture – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing.

UNIT- V: Predators, Parasites, and Pathogens of Earthworms and their control. Future perspectives – Potentials and constraints for vermiculture in India.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To understand various applications of Vermitechnology	✓	✓	✓	✓	
• To identify earthworm species used in organic waste management	✓	✓	✓	✓	
• To use earthworms in bioremediation of industrial wastes	✓	✓	✓	✓	
• To become an entrepreneur by culturing earthworms	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Morphology and Anatomy	K1, K2	14.4
II	Vermiculture & Culture methods	K1, K2	14.4
III	Applications of vermiculture	K1, K2, K3, K6	14.4
IV	Advantages of Vermitechnology	K1, K2, K3, K4, K5, K6	14.4
V	Diseases and control	K1, K2, K3, K4, K5, K6	14.4

REFERENCES

1 Edwards, C.A. Arancon, N.Q. and Sherman, R. 2011. Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management. CRC Press, Boca Raton, FL.

2 Karaca, A. 2011. Biology of Earthworms (Soil Biology Book-24). Springer Publishers.

3 Ranganathan, L.S. 2006. Vermibiotechnology – From Soil Health to Human Health. Agrobios, India.

4 Ismail, S.A. 2005. The Earthworm Book. Second Edition, Other India Press, Apusa, Goa, India.

5 Edwards, C.A. 2004. Earthworm Ecology. CRC Press, Boca Raton, FL.

6 Ismail, S.A. 1997. Vermicology: The Biology of Earathworms. 1st Edition, Orient Longman, India.

Elective Paper: 04 **Paper Code: 20ZOOE04**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ECONOMIC ENTOMOLOGY

Objectives:

- Main objective is to provide basic knowledge on the largest group of animals in the world.
- The units are designed to provide basic and advanced knowledge and practical skills on the beneficiary insects.
- The subject is also designed to learn and overcome the problems faced during culture of silkworms and bees.

Outcome:

- You will have a strong foundation on classification, structure and behavior of insects as whole.
- You could be a leading entrepreneur by using the gained knowledge and practical skills on sericulture and apiculture.
- You will able to provide novel ideas and techniques to farmers from the experience and knowledge gathered during the study.

UNIT -I:

AN OVERVIEW OF CLASS INSECTA: Classification of Insects. External morphology of Insects – Types of mouthparts, Antennae, wings and legs. Life cycle of insects – Types of metamorphosis.

UNIT -II:

ECONOMIC IMPORTANCE AND SILKWORM BIOLOGY: Prospects and status - *Bombyx mori* - life cycle - Structure of the silk gland - Physiology of molting - Genetics - mutation breeding. **MORICULTURE**: Mulberry - varieties & distribution - methods of cultivation and preparation – Harvesting methods - Pest and diseases.

UNIT-III:

DISEASES AND PEST: Viral, bacterial, fungi and protozoan diseases - control mechanisms. Uzifly menace. **SILKWORM REARING AND SILK REELING:** Rearing operations - Selection and construction of rearing house Incubation - Reeling techniques – Lacing, skinning and re-reeling.

UNIT-IV:

APICULTURE: Introduction and present status. Distribution and behavior of *Apis dorsata*, *Apis cerana indica*. Structure & Morphology, Life cycle, colony organization, division of labour and communication.

UNIT-V:

BEE REARING: Beekeeping equipments, beekeeping and its products. Diseases and pests of Bees: Bacterial, fungal and viral diseases. Bee pests: Mites, beetles and moths. Management of pests and diseases.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To gain knowledge on agricultural store grain pest	✓	✓	✓	✓	✓
• To gain knowledge in Apiculture and Sericulture	✓	✓	✓	✓	✓
• To gain knowledge on pest management	✓	✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	An overview of class insecta	K1, K2	14.4
II	Economic importance and silkworm biology	K1, K2, K6	14.4
III	Diseases and pest	K1, K2, K6	14.4
IV	Apiculture	K1, K2, K6	14.4
V	Bee rearing	K1, K2, K6	14.4

REFERENCE BOOKS

1 Eikichi, H. (1999). Silkworm Breeding (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

2 Ganga, G. (2003). Comprehensive Sericulture Vol-II: Silkworm Rearing and Silk Reeling.

3 Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

4 R. F. Chapman (1998). The Insects*:* Structure and Function. Cambridge University Press - 770 pages.

5 Mishra, R.C., and Garg, R (1997). Prospectives in Indian Apicutlure, Agro-Botanica New Delhi, p - 412.

6 Sardar Singh, (1962). Bee keeping in India, Indian Council of Agricultural Research, The University of Michigan.

7 Roger, M (1990). The ABC and Xyz of Bee Culture: An Encyclopedia of Beekeeping, Kindle Edition.

Supportive Paper: 01 **Paper Code: 20ZOOS01**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

MOLECULAR ONCOLOGY

Objectives:

- Strive the students to understand the basic knowledge on biology of cancer
- to provide basic practical skills on the beneficiary treatment modalities.
- The subject is also designed to learn and how do we overcome the problems faced during cancer progression.

Outcome:

The students opt this subject as supportive that could develop his/her to be a professional oncologist to characterize the cancer at molecular level and have a chance to work as histopathologists in molecular oncology laboratories.

UNIT - I

History, scope and current scenario of cancer research. Cancer – Types and their prevalence – - Classification based on origin/organ: breast, colon, lung, prostrate, cervical and oral cancers.

UNITII

Molecular mechanism of oncogenesis – Proto oncogenes, oncogene, oncoproteins, tumour suppressor genes and gene products like p53 proteins and receptors proteins involved in cancer targetting.

UNITIII

Apoptosis and cancer: Mechanism of apoptosis - proteins involved in apoptosis-Signaling pathways: Significance of –RB, Cyclins, CDKs, related pathways – Relationship between cancer and anti-apoptotic proteins.

UNIT - IV

Principle and methods of cancer diagnosis: – Biochemical, Genetic, Cytotoxic and cell growth and viability tests. Current status of cancer proteomics. Cancer Gene Therapy – concepts and applications.

UNIT - V

Cancer therapy – at cellular level- at gene level- at protein level. Principles of cancer biomarker and their applications – chemotherapeutics for cancer, Phytotherapy for cancer.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To become researcher in oncology	✓	✓	✓	✓	✓
• To gain knowledge in etiology and epidemiology of various cancers	✓	✓	✓	✓	
• To acquire knowledge about molecular biology of cancer	✓	✓	✓	✓	✓
• To develop practical skills in diagnosis of various cancers	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	History & scope	K1, K2	10.8
II	Molecular mechanism of oncogenesis	K1, K2	10.8
III	Apoptosis and cancer	K1, K2, K6	10.8
IV	Principle and methods of cancer diagnosis	K1, K2, K3, K6	10.8
V	Cancer therapy	K1, K2, K3, K6	10.8

REFERENCE BOOKS:

1. Tannock IF and Hill RP (1998) The Basic Science of Oncology, Third edition, McGraw- Hill, New York.

2. Bronchud MH, Foote M, Giaccone G, olopade O and Workman P(2017) Principles of Molecular Oncology, Fifth edition, Humana Press, New Jersey.

3. Depatin KM and Fulda S (2015) Apoptosis and Cancer Therapy, WILEY-VCHVerlag GmbH and Co., New York.

4. Hayatt MA (2016) Methods of Cancer Diagnosis, Therapy, and Prognosis, Vol-7; Springer, Netherlands.

5. Missailidis S (2012) Anticancer Therapeutics, John Wiley and Sons, Ltd., USA.

Supportive Paper: 02 **Paper Code: 20ZOOS02**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-II
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

VERMICULTURE AND VERMICOMPOSTING

Course Objectives:

- To introduce the term Vermitechnology to the students.
- To understand the concepts of vermiculture and vermicomposting.
- To understand the characteristics of earthworm species suitable for vermiculture and vermicomposting.
- To understand various applications of earthworms in organic solid waste management, soil fertility, and bioremediation.

Course Outcomes:

On successful completion of this course, the student will be able to:

- Understand the core concepts of vermiculture and vermicomposting.
- Identify the earthworm species suitable for vermiculture and vermicomposting.
- Apply vermitechnology in vermicomposting, soil fertility, and bioremediation processes and become an entrepreneur.

UNIT - I

Earthworms – Taxonomic position and diversity; types – morphological and ecological grouping – Epigeic, Anecic and Endogeic species; Ecological role and economic importance of earthworms.

UNIT - II

Vermiculture – definition, scope and importance; Local and exotic species for culture; Environmental requirements; Culture methods – wormery – breeding techniques; indoor and outdoor cultures – monoculture and polyculture.

UNIT - III

Applications of vermiculture – Vermicomposting – use of vermicastings in organic farming, Earthworms for management of municipal organic solid wastes. Nutrient value of worm cast/vermicompost – Effect of vermicompost on plants.

UNIT - IV

Marketing the products of vermiculture – quality control, market research, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport.

UNIT - V

Future perspectives – Predator/pathogen control in wormeries; Potentials and constraints for vermiculture in India.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To understand various applications	✓	✓	✓	✓	
• To identify earthworm species used in organic waste management	✓	✓	✓	✓	
• To use earthworms in bioremediation of industrial wastes	✓	✓	✓	✓	
• To become an entrepreneur	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Morphology and anatomy	K1, K2	10.8
II	Vermiculture & Culture methods	K1, K2	10.8
III	Applications of vermiculture	K1, K2, K3, K6	10.8
IV	Marketing	K1, K2, K6	10.8
V	Future perspectives	K1, K2, K6	10.8

REFERENCE BOOKS:

1 Edwards, C.A. Arancon, N.Q. and Sherman, R. 2011. Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management. CRC Press, Boca Raton, FL.

2 Karaca, A. 2011. Biology of Earthworms (Soil Biology Book-24). Springer Publishers.

3 Ranganathan, L.S. 2006. Vermibiotechnology – From Soil Health to Human Health. Agrobios, India.

4 Ismail, S.A. 2005. The Earthworm Book. Second Edition, Other India Press, Apusa, Goa, India.

5 Edwards, C.A. 2004. Earthworm Ecology. CRC Press, Boca Raton, FL.

6 Ismail, S.A. 1997. Vermicology: The Biology of Earathworms. 1st Edition, Orient Longman, India.

Core Paper: 10 **Paper Code: 20ZOOC10**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

IMMUNOLOGY

Course Objectives:

- To motivate students to learn the lymphoid organs of our body
- To make them understand the different types of immune globulins
- To get knowledge about different types of techniques used in immunology

Course Outcome:

- The students will get more knowledge about lymphoid organs
- The students could differentiate the immunoglobulin based on their structures
- Students get overview knowledge about immunology

UNIT I

Historical perspectives, lymphoid organs. Cells of immune system, T and B cell activation and maturation, Haematopoiesis, Haematopoietic stem cells, Class switching, Antigens.The molecular basis of antigen and antibody interactions, Complement system, Types of immunity, Immunization.

UNIT II

Immunoglobulins: Structure and functions of immunoglobulin classes. Hybridoma technology for monoclonal antibody production and designer monoclonal antibodies. Cytokines, interleukins, complement system; Immunostimulation and Immunosuppression and their clinical significance.

UNIT III

MHC gene in human and mouse, Genetics of MHC class I and class II molecules. Autoimmune diseases. Transplantation Immunology- Tissue typing and organ transplantation. Immunobiology of HIV infection.

UNIT IV

Vaccines – whole organism vaccine, synthetic peptide vaccine, multivalent subunit - anti idotype vaccine, designer vaccine, edible vaccine, DNA vaccine, recombinant vector vaccine; Abzymes, current scenario of vaccines and vaccination.

UNIT - V

Principles and applications of immune techniques: Radio Immuno Assay, ELISA, Western Blotting, Immunofluorescence technique, immunohistochemistry. Microarray as a tool for detection of human genetic disorders. Immunodiagnostics and immunotherapy in virology – Serological methods for detection and quantitation of viruses: Hepatitis and Influenza viruses.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To become an immune therapist in hospitals	✓	✓	✓	✓	
• Medical consultant in hospitals	✓	✓	✓	✓	✓
• To develop clinical laboratories	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Historical perspectives, lymphoid organs	K1, K2	14.4
II	Immunoglobulins Structure & Function	K1, K2	14.4
III	MHC gene	K1, K2	14.4
IV	Vaccines	K1, K2, K3, K6	14.4
V	Principles and applications of immune techniques	K1, K2, K3, K6	14.4

REFERENCE BOOKS:

1 Abbas, A. K., and A. H. Lichtman (2017) Cellular and molecular immunology, First-South Asia Edition, Elsevier

2 Delves, P., S. Martin, D. Burton and I. M. Roitt, (2017), Roitt's Essential Immunology, 13th Edition, Wiley – Blackwell publications, USA

3 Murphy, K.M., and Weaver, C (2017) Janeway's Immunology, 9th edition, W.W. Norton & Company, USA

4 Paul, W.E. (2012) Fundamental Immunology, 7th Edition, Lippincott Williams and Wilkins, USA

5 Punt. J., Stranford, S., Jones, P., W. A. Owen (2018). Kuby Immunology 8th Edition, W.H. Freeman & Company, New York.

6 Tizard, I.R. (1995) Immunology-An introduction IV Ed. Saunders College Publications, Philadelphia, USA.

Core Paper: 11 **Paper Code: 20ZOOC11**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ANIMAL CELL CULTURE AND NANOBIOTECHNOLOGY

Objectives:

- Students are motivated to impart knowledge and practical skills on isolation, culture and preservation of animal cells.
- It is also to provide a basic and advanced understanding of pluripotent stem cells.
- This subject also aims to provide knowledge practical skills on the synthesis, characterization and application of different nanoparticles.

Outcome:

- You will be an expertise in cell culture theory and practices.
- On completion of the course you can fit yourselves in the international nanotechnology laboratories reproducing your experience the study period.
- You will have basic and novel ideas for future research on monotherapy for various diseases.

UNIT – I

Animal cell culture: Stages of culturing - cell culture media, cell lines, large scale culture, bioreactor models for animal cell culture, characterization and maintenance of cell lines – telomerase and cellular aging. Cryopreservation and cell bank. Applications of cell line in understanding the basic cell biology.

UNIT – II

Transgenic techniques: use of viral vectors –adenovirus, adeno associated virus, retroviral vectors. Stem cells – Definition, functions and origin, types, stem cell therapy, stem cell culture. Cloned genes and production of recombinant proteins and vaccines. Insulin, somatotrophin, Human interferons. Hepatitis B virus vaccine; DNA vaccine.

UNIT – III

Scope of Nanobiotechnology– Landmarks in Nanobiotechnology – Current Scenario of Nano Science and Technology. Synthesis of Nano materials – Biological Methods and Chemical Methods – Chemical Vapor condensation and Sol gel methods. Synthesis of Gold, Silver, Ormosil and Iron oxide nanoparticles. Monodispersion of Nanoparticles.

UNIT – IV

Characterization of Nano materials: Physical Method – Zeta potential, SEM, TEM and AFM. Chemical Method – Principle and Applications of UV visible Spectrophotometer, FT-IR spectroscopy, NMR and XRD. Biological Methods: MTT Assay, XTT Assay.

UNIT – V

Development of Drug delivery system: Use of polymers and co-polymers in drug delivery. Methods of drug loading. Evaluation of cytotoxicity, druggability for the drug loaded nano materials. Nanomaterial as gene delivering agent; Uses of Nanomaterials in controlling microbial diseases, biochemical and genetic disorders. Development of Nanomedicine for diabetes and cancer.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To become a researcher in nanotechnology	✓	✓	✓	✓	
• To become an entrepreneur in producing animal model for research	✓	✓	✓	✓	
• To develop mass culture in industries	✓	✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Animal cell culture	K1, K2, K3, K6	14.4
II	Transgenic techniques	K1, K2, K3, K6	14.4
III	Introduction and Synthesis	K1, K2, K3, K6	14.4
IV	Characterization of Nano materials	K1, K2, K3, K6	14.4
V	Development of Drug delivery system	K1, K2, K3, K6	14.4

REFERENCE BOOKS

1 Al-Rubeai M (2015) Animal Cell Culture, Springer.
2 Davis JM (2011) Animal Cell Culture: Essential Methods, Wiley-Blackwell, USA.
3 Dubey RC (2012) A Text Book of Biotechnology, S. Chand Co., New Delhi.
4 Gupta PK (2014) Biotechnology and Genomics, Rastogi Publications, Meerut, India.
5 Mather JP and Barnes D (2003) Methods in Cell Biology, Vol 57 Animal Cell Culture Methods, Academic Press, New York.
6 Potten CS (2010) Stem Cells, Academic Press, London.
7 David J Lockwood (2004) FRSC: Introduction to Nanoscale Science and Technology, National Research Council of Canada Ottawa, Ontario, Canada.
8 Kirkland AI and Hutchison JL (2007) Nanocharacterisation, Department of Materials, Oxford University, Oxford, UK.
9 Yury Gogotsi (2006) Nanomaterials Handbook, Taylor and Francis Group, Boca Raton London, New York.

Core Paper: 12 **Paper Code: 20ZOOC12**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ENVIRONMENTAL BIOLOGY

Course Objectives:

- To understand how interactions between organisms and their physical environment drive the dynamics of individuals, populations, communities, and ecosystems.
- To understand the importance of ecology to issues regarding human welfare.
- To learn about the significance of endemic biodiversity and the need for its conservation.

Course Outcomes:

On successful completion of this course, the student will be able to:

- Understand core concepts and methods from ecological science and its application in environmental problem-solving.
- Understand the importance of ecology to issues regarding human well-being.
- See the connectivity and relevance of ecology to other fields of study.

UNIT I

The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Concept of habitat and niche; fundamental and realized niche; resource partitioning; character displacement. **Ecosystem:** Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine).

UNIT II

Pollution: Air pollution: Source, pollutants and effects of CFC, ozone, acid rain - global warming, emission standards, monitoring and control of pollution. **Water pollution:** Sources, effects - sewage and industrial wastes - BOD, COD. Waste water treatment - eutrophication. - biomagnifications. **Oil pollution:** Coastal pollution - Oil Slicks and Spills, Post-gulf war effects. **Land pollution:** Solid waste accumulation, hospital waste and management.

UNIT III

Population and Community Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection). **Species interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. **Communities:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. **Ecological succession:** Types; mechanisms; changes involved in succession; concept of climax.

UNIT IV

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. **Biodiversity and Conservation biology:** Importance of biodiversity, diversity hot spots, endemic and endangered species - Diversity measurements - Principles of

conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

UNIT V

Environmental Stress and Management: Major classes of contaminants. Uptake, biotransformation, detoxification, elimination and accumulation of toxicants. Impact of chemicals on biodiversity. Bioindicators and biomarkers of environmental health. **Disaster Management:** Natural Disasters – Earthquakes, Volcanic Eruption, Landslides, Cyclones, Tsunamis and Droughts. Man Made Disasters- Fires and Forest Fires. Nuclear, Biological and Chemical disaster.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To become an ecologist and an environmentalist	✓	✓	✓	✓	
• To become forest conservator	✓	✓	✓	✓	
• To work in pollution control board	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	The Environment	K1, K2	14.4
II	Pollution	K1, K2, K6	14.4
III	Population and Community Ecology	K1, K2, K3, K4, K5	14.4
IV	Biogeography	K1, K2, K3, K4, K5	14.4
V	Environmental Stress and Management	K1, K2, K3, K4, K5	14.4

REFERENCE BOOKS:

1) Copsey, J.A. and Black, S.A. 2018. Species Conservation: Lessons from Islands (Ecology, Biodiversity and Conservation). Cambridge University Press.
2) Sharma, B.K. 2015. Environmental chemistry. 11th edition, Goel Publishing House, Meerut.
3) Dhawan, N.G. and Khan, A.S. 2014. Disater Management and Preparedness. (Based on the syllabus prescribed by UGC for Disater Management Education). CBS Publishers. New Delhi.
4) Morin, P.J. 2011. Community Ecology. 2nd edition, Wiley-Blackwell Publishers.
5) Odum, E. and Barrett, G.W. 2005. Fundamentals of Ecology. 5th Edition, Cengage Publishers.
6) Asthana, D.K. and Meera, A. 2001. Environment – Problems and Solution. S. Chand and Company, New Delhi.
7) Sharma, B.K. and Kaur, H. 1997. An Introduction to Environmental Pollution. Goel Publishing House, Meerut.
8) Edward, I.N. 1996. Applied Ecology and Environmental Managament. Wiley-Blackwell Publishers.
9) Sinha, R.K. 1996. Biodiversity - Global Concerns. Common Wealth Publishers.

Core Paper: 13 **Paper Code: 20ZOOC13**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

AQUACULTURE AND FISHERY BIOLOGY

Objectives:

- Main objective is to provide basic knowledge on cultivation of aquatic animals
- to provide advanced knowledge about establishment of aquaculture industry.

Outcome:

- Our stake holders will become the best entrepreneur in the field of aquaculture and fishery industry. Further our students will become a fisher biologist to cultivate genetically engineered fishes in the form of food and ornamental organisms.

UNIT - I

Historical background and present status of aquaculture: purpose and importance of aquaculture. Types of culture systems: Traditional, extensive, semi-intensive, intensive, super-intensive. Characteristic features of cultivable species (Indian major carps, murrels, catfish and tilapia). Selection criteria of cultivable species.

UNIT - II

Types of aquaculture: Freshwater aquaculture, brackish water aquaculture and mariculture, merits and demerits, Design, construction and management of ponds, types of ponds. Control of aquatic weeds and predators.

UNIT - III

Composite fish culture: Mono sex culture, culture of air-breathing fishes, sewage fed fish culture, Fish-cum duck culture: induced breeding of carps: Broodstock management.

UNIT - IV

Fish diseases: Parasitic, protozoan, bacterial, fungal and viral diseases and their control measures. Fish processing and preservation, fishery by-products.

UNIT - V

Inland fisheries: Freshwater, riverine, reservoir, pond and cold-water fisheries. Estuarine and brackish water fisheries and their economics. Fish gears and crafts used in South Indian Fisheries. Marine Fisheries: Sardine, Mackerel, Bombay duck, Sciaenids, Ribbonfish, Silver bellies, Pomfrets, Carangids, Sharks, Shrimps, Prawns, Crabs, Lobsters and Molluscs (Mussels, clams and scallops).

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To develop aquaculture industry	✓	✓	✓	✓	
• To become researcher in fishery biology	✓	✓	✓	✓	
• Entrepreneur in pearl culture	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Historical background and present status	K1, K2, K3	14.4
II	Types of aquaculture	K1, K2, K3	14.4
III	Composite fish culture Technique	K1, K2, K3	14.4
IV	Fish diseases & Control	K1, K2, K3, K4, K5	14.4
V	Inland fisheries	K1, K2, K3, K4, K5	14.4

REFERENCE BOOKS:

1. Mikkola H (2017), Fisheries and Aquaculture In The Modern World. Intech publisher

2. Sandra E. Shumway and G. Jay Parsons (2016), Scallops: Biology, Ecology, Aquaculture, and Fisheries (Developments in Aquaculture and Fisheries Science) (3 Ed) Elsevier Science

3. Khanna SS and Singh HR (2014). A Text Book of Fish Biology & Fisheries, 2nd Edition, Publisher: Narendra Publishing House, New Delhi.

4. John E. Bardach, John H. Ryther, William O. Mclarney (2013). Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms (1st Ed), Wiley India Pvt Ltd.

5. Swain SK (2012), Fisheries and Aquaculture Technology, Swastik Publishers and distributors

6. Moyle PB and Joseph J (2011), Fishes: An Introduction to Ichthyology (5th Ed), Prentice Hall India Learning P. Ltd.

7. Pillay TVR and Kutty MN (2011), Aquaculture: Principles and Practices (2nd Ed), Wiley India Pvt Ltd.

8. Rath RK (2011), Freshwater Aquaculture (3rd Ed), Scientific Publishers Journals Dept.

9. Srivastava C B L and Sushma (2006), A Text Book of Fishery Science and Indian Fisheries, Kitab Mahal, New Delhi.

Core Practical Paper: 03 **Paper Code: 20ZOOP03**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

LAB COURSE-III

Course Objectives:

- To motivate students to learn immuno-techniques
- To understand how do separate proteins and DNA
- To get knowledge about different types of nanobio-techniques

Course Outcome:

- These hands on training course would support the students to get into research with throughput ideas. Chance for them to work in molecular biology laboratories.

1. Radial immunodiffusion
2. Double immunodiffusion
3. Blood Group Testing
4. Immuno electrophoresis
5. Widal Test – Quantitative and Qualitative Method
6. Isolation of plasmid DNA and Agarose Gel Electrophoresis
7. Isolation of chromosomal DNA from human blood
8. SDS PAGE to determine protein Molecular Weight
9. Placoid and Tenoid scale
10. Synthesis of Silver Nanoparticle
11. Biosynthesis of Gold Nanoparticle
12. Characterization of Synthesized Nanoparticle using UV-Visible Spectrophotometer
13. Population Estimation of Soil organisms
14. Determination of Dissolved oxygen by Wrinkler's Method
15. Fauna of Pond and Grass land Ecosystems in Periyar University Campus.

SPOTTERS

1. MCF-7 cells
2. A549 Cells
3. ZR751Cells
4. HepG2 Cells
5. Electrophoresis unit
6. Autoimmune diseases
7. ELISA Reader
8. DAPI Staining Picture
9. AO/EtBr Staining Picture
10. Apoptotic Cells
11. Zeta analyzer
12. Scanning electron Microscope
13. X-Ray Diffraction
14. Rocket Gel Immuno Electrophoresis

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Develop skills on blood group testing	✓	✓	✓	✓	
• Develop skills AGE & PAGE	✓	✓	✓	✓	
• Skills on synthesis of nanoparticles	✓	✓	✓	✓	✓
• Develop knowledge on various cell lines	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Molecular oncology	K1, K2, K3, K4, K5	21.6
II	Immunology	K1, K2, K3, K4, K5	21.6
III	Animal cell culture and nanobiotechnology	K1, K2, K3, K4, K5	21.6
IV	Environmental biology	K1, K2, K3, K4, K5	21.6
V	Aquaculture and fishery biology	K1, K2, K3, K4, K5	21.6

REFERENCE BOOKS

1. Hay FC and Westwood OMR (2008) Practical Immunology, John Wiley and Sons.
2. Wilson K and Walker JM (2010) Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press.
3. Yadav B (2012) Bioinformatics: A practical guide for Molecular Biologists LAP Lambert Academic Publishing.
4. Green MR and Sambrook J (2012) Molecular cloning: a laboratory manual, 2nd ed. Cold Spring Harbor, N.Y.: Cold Spring Harbor Laboratory Press.
5. Kannan S, Krishnan M, Thirumurugan R and Achiraman S (2012) Methods in Molecular Biology, UVN Publishers, India.

Elective Paper: 05 **Paper Code: 20ZOOE05**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

CANCER AND STEM CELL BIOLOGY

Course Objectives:

- To motivate students to learn the fundamentals of cancer
- To enable the students to know how the stem cells are functioning
- To get knowledge about different types of molecular techniques.

Course Outcome:

- This course work provides chance to work in stem cells and cancer stem cells. There is a chance for the students to enter into the modern cancer and stem cell laboratories as scientist.

UNIT I

Regulation of the Eukaryotic cell cycle, Cancer biomarkers, Primary and established cell lines, Kinetics of Cancer cell growth, Genetics of cancer biology. Cancer stem cell culture and their applications. Cell culture-based vaccines. Cancer proteomics at a glance.

UNIT II

Cell Signaling in Cancer Cells and Signaling at the cell surface level, Types of signaling pathways that control gene activity in m=normal and cancer cells, endocytotic and exocytotic proteins in membranes and organelles, Vascular traffic, Metabolism and movement of lipids.

UNIT III

Etiology, epidemiology, diagnosis and treatment of Breast, Lung, and colo-rectal, cancers. Current scenario of micro-RNA technology in cancer medicine. Role of DNA vaccination in cancer treatment.

UNIT IV

Introduction to Stem cells– Stem cell definition, origin and hierarchy; stem cell properties, Identification and Characterization- potency and differentiation; niche of stem cell; overview of different stem cell types (embryonic stem cell, adult stem cell and induced pluripotent stem cells)

UNIT V

Characterization and properties of ES cells -pluripotency and self-renewal of ES; molecu lar mechanisms regulating pluripotency Mesenchymal stem cell (MSC) Haematopoietic stem cell (HSC) pluripotent stem cell (iPSC), Gene therapy - Therapeutic cloning. Ethical and Social consideration of Stem cell research.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To become researcher in oncology	✓	✓	✓	✓	✓
• To gain knowledge in etiology and epidemiology of various cancers	✓	✓	✓	✓	
• To acquire knowledge about molecular biology of cancer	✓	✓	✓	✓	✓
• To develop practical skills in diagnosis of various cancers	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Regulation of the Eukaryotic cell cycle	K1, K2, K3, K4, K5	14.4
II	Cell Signaling	K1, K2, K3, K4, K5	14.4
III	Etiology, Epidemiology and Tehranostics	K1, K2, K3, K4, K5, K6	14.4
IV	Introduction to Stem cells	K1, K2, K3, K4, K5, K6	14.4
V	Applications of cancer stem cells	K1, K2, K3, K4, K5, K6	14.4

REFERENCE BOOKS:

1. Turksen K (2002) Embryonic Stem Cells Method and Protocols. Humana press.

2. Korobkin R and Munzer SR (2007) Stem Cell Century, Law and Policy for a Breakthrough Technology, Yale University Press.

3. Lanza R (2004) Hand Book of Stem Cells Volume 1and2, Elsevier press.

4. Committee R (2004) Stem Cells and the Future of Regenerative Medicine by on the Biological and Biomedical Application of Stem Cell Research.

5. Robertis EDP and De Robertis EMF (2005) Cell and Molecular Biology, (8th edn), De, B.I.Waverly Pvt. Ltd., New Delhi.

6. Lodish H, Kaiser CA, Brasher A, Amon A, Berk A, Kreger M, Ploegh H and Scott MP (2012) Molecular Cell Biology, 7th edition, Garland Publishing, Inc. New York.

7. Kiessling, A.A. 2006. Human Embryonic Stem Cells (Second Ed.) Jones & Barlett Publishers.

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Elective Paper: 06 **Paper Code: 20ZOOE06**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

RESEARCH METHODOLOGY

Course objectives:

- To promote research atmosphere among student's community.
- To support to do independent research.

Course outcome:

- This course work paves the way for bringing research outcome for the betterment of our society. Students will get an opportunity to enter into Industry or research institute as technician or statistician.

Unit I:

Microbiological Techniques - Media Preparation and sterilization - Inoculation and growth monitoring, Microbial identification. Microsocopy: Principle & applications - Light microscope and phase contrast microscope - Fluorescence microscope - Electron microscope (SEM & TEM) - Confocal microscopy. Principle and applications of - Spectrophotometer

Unit II

Cryotechniques - Cryopreservation of cells and tissues, freeze drying. Separation techniques. -Chromatography, principle type and applicantion. Electrophoresis, Principles, types and applications -PAGE and agarose gel electrophoresis. Immunological techniques - Immunodiffusion (Single & Double) - Immuno electrophoresis Techniques

Unit III

Cell culture techniques. - Design and functioning of tissue culture laboratory - Culture media, essential components and Preparation - Cell viability testing.Principle and Applications of Flowcytometry, *in situ* hybridization (radio labelled and non-radio labelled methods) - FISH – Polymerase chain reaction (PCR), Blotting DNA Sequencing types and applications

Unit IV

Introduction, Statistical data, organization, classification and tabulation of data; Frequency distribution and graphical representation of data Measures of central tendency (Mean, Median and Mode), Measures of dispersion variance, standard deviation, coefficient of variance Basics of Probability and Probability distribution.

Unit V

Statistical hypothesis – types, testing (hypothesis, null hypothesis, alternate hypothesis Parametric tests – Student's t-Test; Analysis of Variance (ANOVA or F-Ratio: One way and Two-way analysis); Chi-square test (Test of Independence and Test of Goodness of Fit) Correlation and regression analysis concepts and their application

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To gain knowledge in microbial technology	✓	✓	✓	✓	✓
• To gain knowledge in cryotechniques	✓	✓	✓	✓	✓
• Become an biostatistician	✓	✓	✓	✓	
• Statistical advisor in publication division	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Microbiological Techniques	K1, K2, K3, K4, K5, K6	14.4
II	Cryotechniques	K1, K2, K3, K4, K5, K6	14.4
III	Cell culture techniques	K1, K2, K3, K4, K5, K6	14.4
IV	Mean, Median and Mode	K1, K2, K3, K4, K5	14.4
V	Statistical hypothesis	K1, K2, K3, K4, K5, K6	14.4

REFERENCES:

1. Keith Wilson and John Wlaker (2014) Principles and techniques of Practical Biochemistry and molecular biology 10th Edition. Cambridge University Press.

2. Geofferoy M. Cooper (2013) The Cell- A Molecular Approach. ASM Press New York.

3. Frederick M. Ausubel, Roger Brent, Robert E. Kingston,David D. Moore, J. G. Seidman, John A. Smith, Kevin Struhl 2010 Short Protocols in Molecular Biology, 5th Edition, 2 Volume Set. Wiley publication.

4. Gurumani, N. 2004. Introduction to Biostatistics, M.J.P. Publishers, Delhi.

5. Das, D and Das, A.2004. Statistics in Biology and Psychology Academic Publishers, Kolkata.

6. R. Ian Freshney. 2011 Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th Edition. Wiley publication.

7. Robert D Braun (1987) Introduction to instrumental analysis- -McGraw Hill.

8. B L Williams and K Wilson (1981) A biologist Guide to principles and Techniques of Practical Biochemistry. Edward Arnold, London. 1981.

Supportive Paper: 03 **Paper Code: 20ZOOS03**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ENTREPRENEURIAL ZOOLOGY

Objectives:

- This subject provides knowledge on all the entrepreneurial aspects of fauna.
- Every unit is designed to deliver in-depth knowledge on marketing of highly valuable animal products.
- The subject is also designed to learn and overcome the problems faced during culture and marketing of animal products.

Outcome:

- You will develop knowledge of decision making on appropriate technique based on the environment and conditions.
- Students completing the course will have all entrepreneur qualities especially in selecting the right business at the right environment.
- Economically poor students could also develop small scale business based on the available sources.

UNIT I:

Sericulture: History and present status - Sericulture in India - Types of silkworms and distribution. Silkworm rearing technology, Food plant cultivation, seed production, reeling, re-reeling, twisting, doubling and weaving. Diseases and pests of Silkworm: Protozoan, Viral, Bacterial and fungal diseases. Silkworm pests: —Indian Uzifly and Dermistid beetles

UNIT II:

Introduction to Aquaculture. Culture systems. Types of aquaculture. Pond Ecology - Preparation of ponds. Prevention and control of weeds. Parasitic, protozoan, bacterial, fungal and viral diseases and management. Culture of Prawns. Processing, preservation and commercialization of the products.

UNIT III:

Apiculture: Introduction and present status. Distribution and behavior of Apis dorsata, *Apis cerana indica*. Structure & Morphology, Life cycle, colony organization, division of labour and communication. Beekeeping equipments, beekeeping and its products. Diseases and pests of Bees: Bacterial, fungal and viral diseases. Bee pests: Mites, beetles and moths. Management of pests and diseases.

UNIT IV:

Introduction to Live feeds. Live feed species and their nutritional value. Rearing and maintenance of live feeds. Habitat maintenance for natural feed production. Mass culture techniques: Rearing and maintenance of phytoplankton and zooplanktons, Methods of collection, Different media used in culture, Application in hatcheries.

UNIT V:

Oyster culture: History and present status. Seed production of oysters and collection methods. Habitat management – Preparation of nurseries, Feed and nutrition, Factors affecting nurseries and development. Edible oysters and Pear oysters. Predators, Diseases and Environmental factors that affect oysters.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To gain knowledge on economic importance of honey and other bee products	✓	✓	✓	✓	✓
• To develop new techniques in fish culture	✓	✓	✓	✓	✓
• To establish silk industry	✓	✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Sericulture	K1, K2, K3, K4, K5	10.8
II	Aquaculture	K1, K2, K3, K4, K5	10.8
III	Apiculture	K1, K2, K3, K4, K5	10.8
IV	Live feed culture	K1, K2, K3, K4, K5	10.8
V	Oyster culture	K1, K2, K3, K4, K5	10.8

References:

1 Eikichi, H. (1999). Silkworm Breeding (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

2 Ganga, G. (2003). Comprehensive Sericulture Vol-II: Silkworm Rearing and Silk Reeling.

3 Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

4 Ganga, G. and SulochanaChetty, J. (1997).An Introduction to Sericulture. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

5 Hisao Aruga. (1994). Principles of Sericulture (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

6 Mahadevappa, D., Halliyal, V.G., Shankar, D.G. and Bhandiwad, R., (2000). Mulberry Silk Reeling Technology Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

7 Otsuki, R. and Sato, S.(1997). Silkworm Egg Production (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

8 Soo-Ho Lim, Young-Taek Kim, Sang-Poong Lee. (1990). Sericulture Training Manual - Published by FAO - USA. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

9 Veda, K., Nagai, I. and Horikomi, M. (1997). Silkworm Rearing (Translated from Japanese).

10 Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

11 Wu Pang-Chuan and Chen Da-Chuang.(1994). Silkworm Rearing - Published by FAO - USA. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Supportive Paper: 04 **Paper Code: 20ZOOS04**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ADVANCES IN ZOOLOGY

Objectives:

To strive the minds of our stake holders to

- gain knowledge on tools and techniques adapted to produce transgenic animals.
- cater the in-depth knowledge on valuable animal products and their applications.

Outcome:

- Altogether, this subject will bring our students to develop transgenic animals and that could be more useful to the scientific community to solve various animal related problems.

UNIT I

Recent Advances in Animal Biotechnology: Tools and techniques in gene manipulation - antisense RNA technology, DNA and protein chip – Protein engineering – Gene knock out-RNAi and Gene silencing - Application of genetic engineering in medical, agriculture, animal husbandry – Transgenesis Bioethics and IPR.

UNIT II

Current Scenario of Nanomedicine: Nanoparticle as drug carriers- Nanoparticles as gene carrier- Nanoparticle as RNAi carriers. Development of nanomedicine to target cancer. Commercialized nanocarriers for cancer treatment. Impact of nano in cancer biology. Tumor immunology, immunodiagnostics and disease tragetting with monoclonal antibodies.

UNIT III

Behavioural Genetics: Beyond Mandal Laws, Biological Clock and its genetic regulation. Pathways between genes and behaviour, Epigenesis, Genetic and Environmental influences of behaviour. Proteome of Circadian rhythm in Mammals.

UNIT IV

Immunity in Health Care: Cell fusion methods. Hybridoma technology and its applications. Stem cell research; haemopoietic stem cells, embryonic stem cells in health care. Cell culture products. Production of interferons, interleukins and vaccines through mammalian cell cultures.

UNIT V

Molecular Entomology: Insect Molecular Physiology an Over view- Insect Pest Management, Role of Storage proteins in Insect Development (Embryo and Metamorphosis)-Vitellogenin in and receptor interaction in insect - Nanoparticles in Insect Pest Management. Pros and cons of Bacillus thuriengenesis in Pest Management.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To develop valuable animal products	✓	✓	✓	✓	
• To become researcher in transgenic animal technology	✓	✓	✓	✓	
• To become nanopharmacologist	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters (K1, K2)	Hours of Instruction
I	Recent Advances in Animal Biotechnology	K1, K2, K3, K4, K5, K6	10.8
II	Current Scenario of Nanomedicine	K1, K2, K3, K4, K5, K6	10.8
III	Behavioural Genetics	K1, K2, K3, K4, K5, K6	10.8
IV	Immunity in Health Care	K1, K2, K3, K4, K5, K6	10.8
V	Molecular Entomology	K1, K2, K3, K4, K5, K6	10.8

REFERENCES

1 Eikichi, H. (1999). Silkworm Breeding (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

2 Ganga, G. (2003). Comprehensive Sericulture Vol-II: Silkworm Rearing and Silk Reeling.

3 Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

4 Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson. (2014). Molecular Biology of the Cell, 3rdEdition, International Students Publication.

5 USA

6 Primrose SB and R.M.Twyman (2015) Principles of Gene Manipulation and Genomics Blackwell Publishing, USA.

7 Salle AJ (1999) Fundamental Principles of Bacteriology. 7th edition, Tata- McGraw Hill.

8 Yury Gogotsi (2006) Nanomaterials Handbook, Taylor and Francis Group, Boca Raton London, New York.

Project Work **Paper Code: 20ZOOPR01**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-IV
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

Project Work and *viva voce*

Course Objectives:

To enable the students

- To gain research knowledge.
- To know how to execute independent research.

Course Outcome:

At the completion of this course, students will be able to do independent research at national and international standard.

Aim: (a) Application of knowledge to real life situation (b) to introduce research methodology. Topic of dissertation may be chosen from any area of Zoology and may be laboratory based, field based or both or computational, with emphasis on originality of approach. It may be started during 2nd / 3rd semester and shall be completed by the end of the 4th semester. The Dissertation to be submitted should include (a) background information in the form of introduction (b) objectives of the study (c) materials and methods employed for the study (d) results and discussion thereon (e) summary and conclusions and (f) bibliography. Apart from these sections, importance of the results, originality and general presentation also may be taken into consideration for evaluation.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To develop research skills		✓	✓		✓
• Develop novel thinking ability		✓	✓		✓
• Knowledge on publications, patents, product developments etc.		✓	✓		✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters	Hours of Instruction
I	Specialization topic of research supervisor	K3, K4, K5, K6	468

Extra Credit Paper: 01 **Paper Code: 20ZOOEC01**

PERIYARUNIVERSITY, SALEM
Department of Zoology
M.Sc. Zoology Course - SEMESTER-IV
(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

SOFT SKILL DEVELOPMENT (Extra Credit Paper)

STATISTICAL PACKAGE FOR THE SOCIAL SCIENCES (SPSS)

Course Objectives:

- This course is intended for students with limited or no experience with SPSS.
- This course will give students a brief overview of creating data files, running statistical analysis, and reading output.

Course Outcome:

At the completion of this course, students will be able to:

- Prepare and manipulate datasets for analysis in SPSS.
- Conduct simple descriptive and graphic analyses of data in SPSS.
- Prepare a report with a summary of analyses conducted in SPSS.

UNIT I

Definition; Scope of Biostatistics, Variables in biology; Population and sampling, sampling distribution; Difference between parametric and non – parametric statistics; Data Collection, Classification, Tabulation. Introduction to Statistical Package for Social Sciences (SPSS) for windows. Variable naming on SPSS –data entry, Analysis of data – Formulation of frequency tables.

UNIT II

Measures of central tendency – Mean, Median, and Mode; Measures of dispersion – Range, standard deviation and Standard Error; Skewness and kurtosis; Diagrammatic representation – Bar and pie chart , histogram, frequency polygon, Frequency Curve , Logarithmic curves, Scatter plot and line graphs.

UNIT III

Correlation – Types, methods – Graphic, mathematical- Pearson's correlation co-efficient, Regression – Simple linear regression, regression equation and regression line.

UNIT IV

Elements of probability – Probability distribution – Binomial, Poisson, Normal, Tests of significance – Hypothesis testing- Type Iand Type II error, level of significance. Student 't' test - One sample't' test, Independent sample and Paired't' test.

UNIT V

Chi – square; Chi – square test for Goodness fit; Test for Independence of Attributes. F-test – Analysis of Variance (ANOVA) – One way ANOVA – Two way analysis of variance - Introduction to Multivariate statistics.

Note: Students will work out problems using SPSS package at the time of examination on line.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To become a biostatistician	✓	✓	✓	✓	
• To become a consultant in corporate companies	✓	✓	✓	✓	
• Statistical advisor in publication division	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters	Hours of Instruction
I	Scope of Biostatistics	K1, K2, K3, K4, K5	7.2
II	Measures of central tendency	K1, K2, K3, K4, K5	7.2
III	Correlation & Regression	K1, K2, K3, K4, K5	7.2
IV	Elements of probability	K1, K2, K3, K4, K5	7.2
V	Chi – square & ANOVA	K1, K2, K3, K4, K5	7.2

REFERENCE BOOKS

1 Einspruch, E. L. (2004) Next steps with SPSS. Sage Publications, International educational and Professional Publisher, Thousand Oaks, London, New Delhi.

2 Mille, R. L., Ciaran, A., Fullerton, D. A. and Maltby, J. (2002). SPSS for social scientists (Version 9, 10, 11).Consultant editor- Jo.Campling publishers Palgrave MacMillon (UK.USA) Printed in China.

Value Added course: 01 **Paper Code: 19ZOOV01**

PERIYAR UNIVERSITY, SALEM

Department of Zoology

(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

VERMICULTURE

Course Objectives:

- To understand the concepts of vermiculture and vermicomposting.
- To understand the characteristics of earthworm species suitable for vermiculture and
- vermicomposting.
- To understand various applications of earthworms in organic solid waste
- management, soil fertility, and bioremediation.

Course Outcomes:

On successful completion of this course, the student will be able to understand the core concepts of vermiculture and vermicomposting and then involved in the entrepreneurship to promote agriculture. Successful students will apply vermitechnology in vermicomposting, soil fertility, and bioremediation processes and become an entrepreneur.

UNIT-I: Vermiculture – definition, scope and importance – Earthworm morphology and anatomy – Biology of *Perionyx excavatus & Eisenia fetida* – Ecological Classification of Earthworms.

UNIT-II: Common earthworm species used for culture – Environmental requirements – Culture methods – indoor and outdoor cultures – monoculture and polyculture.

UNIT-III: Vermicomposting materials and methods – Small scale and large Scale Vermicomposting. Factors affecting vermicomposting. Maintenance of Vermicomposting beds.

UNIT-IV: Applications of vermiculture – use of vermicastings in organic farming/horticulture, earthworms for management of municipal organic solid wastes. Nutrient value of worm cast/vermicompost – Effect of vermicompost on plants.

UNIT-V: Advantages of Vermitechnology – Marketing the products of vermiculture – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing – Potentials and constraints for vermiculture in India.

REFERENCES:

Edwards, C.A. Arancon, N.Q. and Sherman, R. 2011. Vermiculture Technology: Earthworms, Organic Wastes, and Environmental Management. CRC Press, Boca Raton, FL.

Karaca, A. 2011. Biology of Earthworms (Soil Biology Book-24). Springer Publishers.

Ranganathan, L.S. 2006. Vermibiotechnology – From Soil Health to Human Health. Agrobios, India.

Ismail, S.A. 2005. The Earthworm Book. Second Edition, Other India Press, Apusa, Goa, India.

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• To understand core concepts of vermiculture and vermicomposting	✓	✓	✓	✓	
• To become an entrepreneurship to promote agriculture		✓	✓	✓	✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters	Hours of Instruction
I	Vermiculture Introduction	K1, K2, K3	7.2
II	Common earthworm species	K1, K2, K3	7.2
III	Vermicomposting materials and methods	K1, K2, K3, K4, K5, K6	7.2
IV	Applications of vermiculture	K1, K2, K3, K4, K5, K6	7.2
V	Advantages of Vermitechnology	K1, K2, K3	7.2

Value Added course: 02 **Paper Code: 19ZOOV02**

PERIYAR UNIVERSITY, SALEM

Department of Zoology

(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

PCR TECHNOLOGY

Course objectives:

- To provide knowledge on the concept of PCR and its uses.
- To provide knowledge on working with PCR
- To identify various diseases using PCR technology

Course outcome:

CO1: Understand the basic principle of PCR reaction and Types and uses of PCR Machine.

CO2: Diagnose various diseases causing culprits at gene level

CO3: Understand various applications of PCR techniques in industries & Clinical Laboratories

CO4: Become an entrepreneur by developing PCR kit.

UNIT-I

History, scope and future prospects of polymerase chain reaction- Invention of PCR Machine and advances in PCR Instrumentation, Working principle of PCR

UNIT-II

Types and Evolution of PCR: qPCR, RT-PCR, Ong PCR, Nested PCR, Inverse PCR, Hot Start PCR, Multiplex PCR, and Solid State PCR

UNIT-III

Sample preparation and handling of chemicals and reagents in PCR laboratory- Bio-safety measures, Good Laboratory Practices

UNIT-IV

Processing of biopsy samples-DNA/RNA isolation and identification of DNA/RNA fragments-Agarose and Polyacrylamide Gel Electrophoresis

UNIT-V

Applications of PCR- Pros and cons of PCR technique –Identification of communicable diseases (Bacterial and viral disease), determination of non-communicable diseases (Cancer and neurological disorders)

Reference books:

1. Kannan S, Krishnan M, ThirumuruganR, Archunan G, 2012. Methods in Molecular Biology, SUV Press.
2. Sarah Maddocks and Rowena Jenkins 2016.Understanding PCR 1st Edition A Practical Bench-Top Guide Academic Press
3. Mark A. Behlke, Kornelia Berghof-Jäger, Tom Brown (2019). Polymerase Chain Reaction: Theory and Technology Publisher: Caister Academic Press.

4. Thomas Weissensteiner Tania Nolan Stephen A. Bustin , Hugh G. Griffin Annette Griffin 3003 PCR Technology: Current Innovations, Second Edition (Weissensteiner, PCR Technology) CRC Press
5. Henry A. Erlich PCR Technology: Principles and Applications for DNA Amplification Palgrave Macmillan, London

Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
• Understand the basic principle of PCR reaction and Types and uses of PCR Machine.	✓	✓	✓	✓	
• Diagnose various diseases causing culprits at gene level.		✓	✓	✓	✓
• Understand various applications of PCR techniques in industries & Clinical Laboratories		✓	✓	✓	
• Become an entrepreneur by developing PCR kit.					✓

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters	Hours of Instruction
I	History, scope and future prospects	K1, K2, K3	7.2
II	Types and Evolution of PCR	K1, K2, K3	7.2
III	Sample preparation and handling	K1, K2, K3, K4, K5, K6	7.2
IV	Processing of biopsy samples	K1, K2, K3, K4	7.2
V	Applications of PCR	K1, K2, K3, K4, K5, K6	7.2

Add-on course: 01 **Paper Code: 19ZOOA01**

PERIYAR UNIVERSITY, SALEM

Department of Zoology

(This syllabus is applicable to the students who are admitted on or after 2020-2021 academic year onwards)

ORNITHOLOGY

Course Objectives:

- To know about the diversity of birds in and around Periyar University
- To learn the different types of calls produced by the birds
- To understand the conservation status of birds in India
- To study the mechanism of bird flight

Course Outcomes:

On successful completion of the course, the student will be able to

CO 1- Identify the birds present in and around Periyar University

CO 2- Recognize the birds through the calls emitted by them

CO 3- To get placement in conservation agencies

Unit: I

Introduction: Ornithology- Evolution and Classification of birds- Importance and Conservation of birds- Bird as a pollinator, as a controller of insects and pests- Bird hotspots in India

Unit: II

Bird Habitats Bird Counting/ Census-Bird Watching: Identification of Birds in flight, Identification through Calls and songs. Equipments used for Bird Watching.

Unit: III

Breeding behaviour of birds- Territoriality, Nest building behaviour, Egg laying and clutch size, Incubation and feeding young, weaning of young one and Brood parasitism

Unit: IV

Activity recording and Ethogram- Flying, Walking, Eating, Perching on trees or wires, Drinking water, Singing, Nesting, Preening, Moulting, Bathing, Dust bath, Flocking, Roosting etc

Unit V

Bird Migration: Causes of Migration-Origin of Migration-Significance of Migration-Disadvantages of Migration. Great Ornithologists of India and World & Societies concern with the conservation of birds.

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Correlation of Programme objectives with course outcomes

COURSE OUTCOME	PO1	PO2	PO3	PO4	PO5
The student will be able to CO 1- Identify the birds present in and around Periyar University	✓	✓	✓	✓	
CO 2- Recognize the birds through the calls emitted by them	✓	✓	✓	✓	
CO 3- To get placement in conservation agencies	✓	✓	✓	✓	

Unit wise programme specific qualification attributes

Unit	Unit Title	Intended Learning Chapters	Hours of Instruction
I	Ornithology Introduction	K1, K2	7.2
II	Bird Habitats Bird Counting	K1, K2, K3, K4	7.2
III	Breeding behaviour of birds	K1, K2, K3, K4	7.2
IV	Activity recording and Ethogram	K1, K2, K3, K4, K5	7.2
V	Bird Migration	K1, K2, K3, K4, K5	7.2

EXPANSION FOR PROGRAM OBJECTIVES (POs)

PO1 : Will get opportunity to work at Zoological Survey of India as a Taxonomist, Animal Conservator / Wild Life Warden

PO2 : To undertake research in the broad spectrum of Zoology at advance level and boost-up the knowledge to appear for CSIR NET/SET.

PO3 : To become Teacher / Professor / academician / Government Employee / Scientist in Pesticide industries / Zoological Museum / Zoological Parks

PO4 : Supports to face competitive exams and will be an entomologist, scientist in various funding agencies, Forensic Science Laboratories.

PO5 : Will become entrepreneur to start Sericulture, Apiculture, Oyster culture, Fishery industries and clinical laboratories.

10. Credit Calculation

Method of teaching	Hours	Credits
Lecture	1	1
Tutorial/Demonstration	1	1
Practical/Internship/self-Learning	2	1

11. CBCS – Scheme of Examinations semester wise structure

Subject code	Title of the paper	Weekly contact hrs	Credits	Internal Marks	External Marks	Total Marks
SEMESTER-I						
20ZOOC01	Invertebrates	4	4	25	75	100
20ZOOC02	Chordates	4	4	25	75	100
20ZOOC03	The Cell	4	4	25	75	100
20ZOOC04	Biochemistry	4	4	25	75	100
20ZOOC05	Principles of Genetics	4	4	25	75	100
20ZOOP01	Lab Course-I (Core papers I-V)	6	3	40	60	100
20ZOOE01	Electives: 1. Microbiology	4	4	25	75	100
20ZOOE02	2. Soft Skill Development					
	Total	**30**	**27**	**190**	**510**	**700**
SEMESTER-II						
20ZOOC06	Animal Physiology	4	4	25	75	100
20ZOOC07	Developmental Biology	4	4	25	75	100
20ZOOC08	Evolution	4	4	25	75	100
20ZOOC09	Animal Behaviour and Endocrinology	4	4	25	75	100
20ZOOP02	Lab Course-II (Core papers VI-IX)	6	3	40	60	100
20ZOOE03	Electives: 1. Vermitechnology					
20ZOOE04	2. Economic Entomology	4	4	25	75	100
20ZOOS01	Supportive: 1. Molecular Oncology	3	3	25	75	100
20ZOOS02	2. Vermiculture & Vermicomposting					
	Total	**29**	**26**	**190**	**510**	**700**
SEMESTER-III						
20ZOOC10	Immunology	4	4	25	75	100
20ZOOC11	Animal Cell Culture and Nanobiotechnology	4	4	25	75	100
20ZOOC12	Environmental Biology	4	4	25	75	100
20ZOOC13	Aquaculture and Fishery Biology	4	4	25	75	100
20ZOOP03	Lab Course-III (Core papers X-XIII)	6	3	40	60	100
20ZOOE05	Electives: 1. Cancer and Stem Cell Biology					
20ZOOE06	2. Research Methodology	4	4	25	75	100
20ZOOS03	Supportive: 1. Entrepreneurial Zoology					
20ZOOS04	2. Advances in Zoology	3	3	25	75	100
	Total	**29**	**26**	**190**	**510**	**700**
SEMESTER-IV						
20ZOOPR01	Project work and *viva voce*	26	12	100	100 (50+50) Int+Ext	200
20ZOOFV01	Field Visit/Industrial Visit Report	**--**	2	50	--	50
20ZOOEC01	Soft Skill Development: Statistical package for the social sciences (Extra Credit Paper)	2	1	40	60	100
20ZOOIO01	Industry oriented paper (Sericulture)	1	1	25	75	100
	Total	**29**	**16**	**215**	**235**	**450**
	CUMULATIVE TOTAL	**117**	**95**	**785**	**1765**	**2550**

Only one Soft core /and one Elective paper should be selected / semester.

*Students should submit Field Visit/Industrial Visit Report and to be evaluated by the faculty deputed by the Head Of the Department.

12. Examinations

Examinations are conducted in semester pattern. The examination for the Semester I & III will be held in November/December and that for the Semester II and IV will be in the month of April/May in every academic year.

Candidates failing in any subject (both theory and practical) will be permitted to appear for such failed subjects in the same syllabus structure at subsequent examinations within next 5 years. Failing which, the candidate has to complete the course in the present existing syllabus structure.

13. Scheme for Evaluation and Attainment Rubrics

Evaluation will be done on a continuous basis and will be evaluated four times during the course work. The first evaluation will be in the 7th week, the second in the 11th week, third in the 16th week and the end – semester examination in the 19th week. Evaluation may be by objective type questions, short answers, essays or a combination of these, but the end semester examination is a University theory examination with prescribed question paper pattern.

Attainment Rubrics for Theory Courses

Internal *(Max. Marks - 25)*

S.No.	Approaches	Marks
1	Internal tests (Best two tests out of 3)	10
2	Attendance	5
3	Seminar	5
4	Assignment	5
Total		25

External *(Max. Marks - 75)*

Section	Approaches	Mark Pattern	K Level	CO Coverage
A	One word (Answer all questions)	20X1 = 20 (Multiple Choice Questions)	✓	✓
B	100 to 200 words (Answer any three out of five questions)	3X5 = 15 (Analytical type questions)	✓	✓
C	500 to 1000 words	5X8 = 40 (Essay type questions)	✓	✓

Attainment Rubrics for Lab Courses

Internal *(Max. Marks-40)*

S.No.	Approaches	Marks
1	Practical tests (Best two tests out of 3)	30
2	Attendance	5
3	Record	5
Total		40

External ***(Max. Marks - 60)***

Section	Approaches	Mark Pattern	K Level	CO Coverage
A	Major practical	1X20 = 20	✓	✓
B	Minor practical	1X10 = 10	✓	✓
C	Spotters	4X5 = 20	✓	✓
D	Viva-voce	10	✓	✓
Total		60		

Attainment Rubrics for Research

Internal ***(Max. Marks - 40)***

S.No.	Approaches	Marks
1	Manual involvements in experiments	30
2	Attendance	10
Total		40

External ***(Max. Marks - 60)***

S.No.	Approaches	Marks
1	Project Report	40
2	Viva voce	20
Total		60

14. Grading System

Evaluation of performance of students is based on ten-point scale grading system as given below.

Ten Point Scale			
Grade of Marks	**Grade points**	**Letter Grade**	**Description**
90-100	9.0-10.0	O	Outstanding
80-89	8.0-8.9	D+	Excellent
75-79	7.5-7.9	D	Distinction
70-74	7.0-7.4	A+	Very Good
60-69	6.0-6.9	A	Good
50-59	5.0-5.9	B	Average
00-49	0.0	U	Re-appear
ABSENT	0.0	AAA	ABSENT

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