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**PERIYAR UNIVERSITY**  
**DEPARTMENT OF ZOOLOGY**  
**Salem-636 011, Tamil Nadu**

NAAC "A++" Grade - State University – NIRF Rank 59, NIRF Innovation Band of 11-50

**M.Sc. ZOOLOGY PROGRAMME**  
**[Choice Based Credit System (CBCS)]**  
**(For those admitted in the academic year 2023-2024 onwards)**  
**OBE REGULATIONS AND SYLLABUS**  
**(With effect from the academic year 2023-2024 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 academicians cum Academic advisors for other institutions. Our stakeholders 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 teachers, professors etc.

## 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. M.Sc. Zoology Programme Structure-Course work, contact hours, credits and maximum internal and external marks for the students admitted from 2023-2024 onwards**

| Sem | Course Code                | Title of Course Work  | Contact Hr/Week | Credit    | Int. Mark | Ext. Mark   | Total Mark |
|-----|----------------------------|---|-----------------|-----------|-----------|-------------|------------|
| I   | 23UPZOO1C01                | Structure and Function of Invertebrates   | 6               | 5         | 25        | 75          | 100        |
|     | 23UPZOO1C02                | Comparative Anatomy of Vertebrates  | 6               | 5         | 25        | 75          | 100        |
|     | 23UPZOO1L01                | Core Lab Course I –Invertebrates & Vertebrates  | 6               | 3         | 40        | 60          | 100        |
|     | 23UPZOO1E01<br>23UPZOO1E02 | Biological Chemistry / Microbiology   | 4               | 3         | 25        | 75          | 100        |
|     | 23PUZOO1L02                | Elective Lab Course: Biological Chemistry & Microbiology  | 4               | 2         | 40        | 60          | 100        |
|     | 23UPZOO1E03<br>23UPZOO1E04 | Biostatistics / Advanced Techniques in Zoology  | 4               | 3         | 25        | 75          | 100        |
|     |                            |   | <b>30</b>       | <b>21</b> |           |             | <b>600</b> |
| II  | 23UPZOO1C03                | Cell and Molecular Biology  | 6               | 5         | 25        | 75          | 100        |
|     | 23UPZOO1C04                | Developmental Biology   | 6               | 5         | 25        | 75          | 100        |
|     | 23UPZOO1L03                | Core Lab Course II – Cell & Molecular Biology and Developmental Biology   | 6               | 3         | 40        | 60          | 100        |
|     | 23UPZOO1E05<br>23UPZOO1E06 | Economic Entomology / Medical Parasitology  | 4               | 3         | 25        | 75          | 100        |
|     | 23UPZOO1E07<br>23UPZOO1E08 | Research Methodology / Bioethics & Biosafety  | 4               | 3         | 25        | 75          | 100        |
|     | 23UPZOO1S01                | Skill Enhancement Course [SEC] – I: Poultry Farming   | 2               | 2         | 25        | 75          | 100        |
|     | 23UPZOO1H01                | Human Rights  | 2               | 1         | 25        | 75          | 100        |
|     | 23UPZOO1N01                | Non-Major Elective [NME] – I Swayam Course  | -               | 2         | 25        | 75          | 100        |
|     |                            | <b>30</b>   | <b>24</b>       |           |           | <b>800</b>  |            |
| III | 23UPZOO1C05                | Genetics  | 5               | 4         | 25        | 75          | 100        |
|     | 23UPZOO1C06                | Evolution   | 5               | 4         | 25        | 75          | 100        |
|     | 23UPZOO1C07                | Animal Physiology   | 5               | 4         | 25        | 75          | 100        |
|     | 23UPZOO1L04                | Core Lab Course III – Genetics, Evolution & Animal Physiology   | 6               | 3         | 40        | 60          | 100        |
|     | 23UPZOO1C08                | Core (Industry Module) – XI: Medical Laboratory Techniques  | 2               | 2         | 25        | 75          | 100        |
|     | 23UPZOO1E09<br>23UPZOO1E10 | Stem Cell Biology / Regenerative Medicine   | 3               | 3         | 25        | 75          | 100        |
|     | 23UPZOO1S02                | Skill Enhancement Course [SEC] – II: Dairy Farming  | 2               | 1         | 25        | 75          | 100        |
|     | 23UPZOO1I01                | Internship / Field Survey / Industrial Activity (Internship must be completed during First Year Vacation period of minimum 15 days) | --              | 2         | --        | --          | --         |
|     | 23UPZOO1N02                | Non-Major Elective [NME] – II Cancer Therapeutics   | 2               | 2         | 25        | 75          | 100        |
|     |                            |   | <b>30</b>       | <b>25</b> |           |             | <b>800</b> |
| IV  | 23UPZOO1C09                | Core – XII: Immunology  | 7               | 5         | 25        | 75          | 100        |
|     | 23UPZOO1C10                | Core – XIII: Ecology  | 7               | 5         | 25        | 75          | 100        |
|     | 23UPZOO1P01                | Core – XIV: Project with <i>viva voce</i>   | 10              | 7         | 100       | 50+50       | 200        |
|     | 23UPZOO1E11<br>23UPZOO1E12 | Elective – VI: (Industry Entrepreneurship) Aquaculture / Vermiculture   | 4               | 3         | 25        | 75          | 100        |
|     | 23UPZOO1S03                | Skill Enhancement Course [SEC] – III: Intellectual Property Rights  | 2               | 2         | 25        | 75          | 100        |
|     | 23UPZOO1X01                | Extension Activity  | -               | 1         |           |             |            |
|     |                            |   | <b>30</b>       | <b>23</b> |           |             | <b>600</b> |
|     | <b>Total</b>               | <b>120</b>  | <b>93</b>       | --        | --        | <b>2800</b> |            |

**Total = 93 Credits**

| <b>Value Added Courses (Certificate will be issued separately – Through Online Mode) *</b> |                                      |                      |              |               |
|--|--------------------------------------|----------------------|--------------|---------------|
| <b>Course Code</b>   | <b>Title of Course Work</b>          | <b>Contact Hours</b> | <b>Marks</b> | <b>Credit</b> |
| 23UPZOO1V01  | 3D Cell Biology & Tissue Engineering | 36 hrs per course    | 100          | 2             |
| 23UPZOO1V02  | Genotoxicology                       | 36 hrs per course    | 100          | 2             |
| 23UPZOO1V03  | Insect-Host Interaction              | 36 hrs per course    | 100          | 2             |
| 23UPZOO1V04  | Medical Entomology                   | 36 hrs per course    | 100          | 2             |
| <b>Add-on Courses (Certificate will be issued separately- Through Online Mode) *</b>       |                                      |                      |              |               |
| 23UPZOO1A01  | PCR Technology                       | 36 hrs per course    | 100          | 2             |
| 23UPZOO1A02  | Ornithology                          | 36 hrs per course    | 100          | 2             |

## 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.

## 9. 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 7<sup>th</sup> week, the second in the 11<sup>th</sup> week, third in the 16<sup>th</sup> week and the end – semester examination in the 19<sup>th</sup> 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)

| <b>S.No.</b> | <b>Approaches</b>                        | <b>Marks</b> |
|--------------|--|--------------|
| 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)

| <b>Section</b> | <b>Approaches</b>  | <b>Mark Pattern</b>                   | <b>Level</b> | <b>CO Coverage</b> |
|----------------|--|---------------------------------------|--------------|--------------------|
| A              | Objective Type (Answer all questions)  | 20X1 = 20 (Multiple Choice Questions) | ✓            | ✓                  |
| B              | Descriptive Type (100 to 200 words) (Answer any three out of five questions) | 3X5 = 15 (Analytical type questions)  | ✓            | ✓                  |
| C              | Essay Type (500 to 1000 words) (Answer all questions with internal choice)   | 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 & Record | 10           | ✓       | ✓           |
| Total   |                    | 60           |         |             |

## Attainment Rubrics for Research

### Internal (Max. Mark - 100)

| S.No. | Approaches                         | Marks |
|-------|------------------------------------|-------|
| 1     | Manual involvements in experiments | 30    |
| 2     | Attendance                         | 10    |
| 3     | Submission of Dissertation         | 60    |
| Total |                                    | 100   |

### External (Viva Voce) (Max. Mark - 100)

| S.No. | Approaches                   | Marks |
|-------|------------------------------|-------|
| 1     | Viva Voce- Internal Examiner | 50    |
| 2     | Viva Voce- External Examiner | 50    |
| Total |                              | 100   |

## 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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**M.Sc. Zoology Course - SEMESTER-I**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

### STRUCTURE AND FUNCTION OF INVERTEBRATES

**Core Paper- I**

**Paper Code: 23UPZOO1C01**

**Total Contact Hours: 108**

**Credits: 5**

**Weekly Contact Hours: 6**

|   |  |  |
|---|--|--|
| <b>Course Objectives:</b>   |  |  |
| The main objectives of this course are:   |  |  |
| 1.  | To understand the concept of classification and their characteristic features of major group of invertebrates.                                   |  |
| 2.  | To realize the range of diversification of invertebrate animals.   |  |
| 3.  | To enable to find out the ancestors or derivatives of any taxon.   |  |
| 4.  | To know the functional morphology of system biology of invertebrates.  |  |
| <b>Course</b>   | :  | <b>Core-I (Theory)</b>                         |
| <b>Course title</b>   | :  | <b>STRUCTURE AND FUNCTION OF INVERTEBRATES</b> |
| <b>Credits</b>  | :  | <b>5</b>                                       |
| <b>Pre-requisite:</b>   |  |  |
| Students should know the taxonomical classification of invertebrate animals in relation to their functional morphology. |  |  |
| <b>Expected Course Outcome:</b>   |  |  |
| On the successful completion of the course, student will be able to:  |  |  |
| 1.  | Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms. | <b>K1 &amp; K2</b>                             |
| 2.  | Understand the evolutionary process. All are linked in a sequence of life patterns.  | <b>K2 &amp; K4</b>                             |
| 3.  | Apply this for pre-professional work in agriculture and conservation of life forms.  | <b>K3 &amp; K5</b>                             |
| 4.  | Analyze what lies beyond our present knowledge of life process.  | <b>K4 &amp; K6</b>                             |
| 5.  | Evaluate and to create the perfect phylogenetic relationship in classification.  | <b>K5 &amp; K6</b>                             |

**K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create**

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | Structure and function in invertebrates: Principles of Animal taxonomy; Binomial Nomenclature, Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy; Molecular Taxonomy; r-RNA sequencing, FAME Analysis, Phylogeny of invertebrates. |
| <b>II</b>    | Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata   |

|  |  |
|--|--|
| <b>III</b>   | Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Circulation: Open and Closed Circulatory System, Evolution of Circulatory system; Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory pigments; Mechanism of respiration   |
| <b>IV</b>  | Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malpighian tubules; Mechanisms of excretion; Excretion and osmoregulation. Flight mechanism in Insects; Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda); Trends in neural evolution |
| <b>V</b>   | Invertebrate larvae: Larval forms of free-living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters   |
| <b>Reading list</b>  |  |
| 1. Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.  |  |
| <b>Recommended texts</b>   |  |
| 1. Barnes, R. D. 1974. Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition, pp-1024.   |  |
| 2. Barnes, R. S. K., P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. 2013. The Invertebrates: A Synthesis. Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi. |  |
| 3. Dechenik, J. A. 2015. Biology of Invertebrates (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.   |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | S          | S          | S          | M          | S          | S          | S           |
| <b>CO2</b>                              | S          | S          | M          | M          | S          | S          | M          | M          | S          | S           |
| <b>CO3</b>                              | S          | M          | S          | M          | S          | S          | M          | M          | S          | S           |
| <b>CO4</b>                              | S          | M          | S          | M          | S          | S          | M          | M          | S          | M           |
| <b>CO5</b>                              | S          | M          | S          | M          | S          | S          | M          | M          | S          | M           |

\*S - Strong; M - Medium; L – Low





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**M.Sc. Zoology Course - SEMESTER-I**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

### COMPARATIVE ANATOMY OF VERTEBRATES

**Core Paper-II**

**Paper Code: 23UPZOO1C02**

**Total Contact Hours: 108**

**Credits: 5**

**Weekly Contact Hours: 6**

|  |  |   |
|--|--|---|
| <b>Course Objectives:</b>  |  |   |
| The main objectives of this course are:                              |  |   |
| 1.   | Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.                          |   |
| 2.   | Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.  |   |
| 3.   | Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals                                       |   |
| 4.   | Imparting conceptual knowledge about the animal life in the air and their behaviours.  |   |
| 5.   | Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.                            |   |
| <b>Course</b>  | :  | <b>Core-II (Theory)</b>                   |
| <b>Course title</b>  | :  | <b>COMPARATIVE ANATOMY OF VERTEBRATES</b> |
| <b>Credits</b>   | :  | <b>5</b>                                  |
| <b>Pre-requisite:</b>  |  |   |
| Students with knowledge and comprehension on zoology.                |  |   |
| <b>Expected Course Outcome:</b>                                      |  |   |
| On the successful completion of the course, student will be able to: |  |   |
| 1.   | Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms. | <b>K1 &amp; K2</b>                        |
| 2.   | Understand the evolutionary process. All are linked in a sequence of life patterns.  | <b>K2 &amp; K4</b>                        |
| 3.   | Apply this for pre-professional work in agriculture and conservation of life forms.  | <b>K3 &amp; K5</b>                        |
| 4.   | Analyze what lies beyond our present knowledge of life process.  | <b>K4 &amp; K6</b>                        |
| 5.   | Evaluate and to create the perfect phylogenetic relationship in classification.  | <b>K5 &amp; K6</b>                        |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | Origin of vertebrates: Concept of Protochordata; The nature of vertebrate morphology; Vertebrates: General characters and classification – Prochordata, Agnatha, Gnathostomata, Cartilaginous fishes, Bony fishes- Amphibians, Reptiles, Birds and Mammals. Definition, scope and relation to other disciplines; Importance of the study of vertebrate morphology. |
| <b>II</b>    | Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.   |

|  |   |
|--|---|
| <b>III</b>   | General plan of circulation in various groups; Blood; Evolution of heart; Evolution of aortic arches and portal systems. Respiratory system: Characters of respiratory tissue; Internal and external respiration; Comparative account of respiratory organs   |
| <b>IV</b>  | Skeletal system: Form, function, Dentition in Mammals, Dental formula in man; body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrate series. Flight adaptation in birds. Excretory system – Comparative account of excretory organs.   |
| <b>V</b>   | Sense organs: Simple receptors; Organs of Olfaction and taste; Lateral line system; Electroreception. Nervous system: Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinal cord; Nerves-Cranial, Peripheral and Autonomous nervous systems. Physiology and behavior of mammalian pheromones – Bruce effect, Lee-Boot effect, Vandenberg effect, Flehmen and Lordosis behaviour. |
| <b>Reading list</b>  |   |
| 1. Swayam Prabha <a href="https://www.swayamprabha.gov.in/index.php/program/archive/9">https://www.swayamprabha.gov.in/index.php/program/archive/9</a> |   |
| 2. Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.   |   |
| 3. Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.   |   |
| <b>Recommended texts</b>   |   |
| 1. Waterman, A.J. 1972. Chordate Structure and Function, MacMillan Co., New York, pp.587.  |   |
| 2. Parker T. J. and W. A. Haswell. 1962. A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750.                   |   |
| 3. Ekambaranatha Ayyar and T. N. Ananthkrishnan. 2009. Manual of Zoology, Vol – II, S. Viswanathan Pvt. Ltd. Chennai.                                  |   |
| 4. Kotpal, 2019. R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut, pp-968.                                      |   |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | M          | L          | S          | M          | S          | M          | S          | M          | S           |
| <b>CO2</b>                              | S          | L          | L          | S          | M          | S          | M          | M          | M          | M           |
| <b>CO3</b>                              | S          | M          | L          | S          | M          | S          | M          | L          | M          | M           |
| <b>CO4</b>                              | S          | L          | L          | S          | L          | S          | M          | L          | M          | L           |
| <b>CO5</b>                              | S          | M          | L          | S          | S          | S          | M          | S          | M          | M           |

\*S - Strong; M - Medium; L – Low



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**M.Sc. Zoology Course - SEMESTER-I**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**LAB COURSE I**  
**(INVERTEBRATES & VERTEBRATES)**

**Core Paper-III**

**Paper Code: 23UPZOO1L01**

**Total Contact Hours: 108**

**Credits: 3**

**Weekly Contact Hours: 6**

|  |  |  |
|--|--|--|
| <b>Course Objectives:</b>  |  |  |
| The main objectives of this course are:                              |  |  |
| 1.   | Understanding the different systems in invertebrates & vertebrates.                              |  |
| 2.   | Learning about various animal species, their phylogenetic affinities and their adaptive features |  |
| 3.   | Imparting conceptual knowledge about the salient features and functional anatomy.                |  |
| 4.   | Developing the skill in mounting techniques of the biological samples.                           |  |
| 5.   | Gaining fundamental knowledge on the skeletal system   |  |
| <b>Course</b>  | :  | <b>Core-III (Practical)</b>                          |
| <b>Course title</b>  | :  | <b>Lab Course-I: Invertebrates &amp; Vertebrates</b> |
| <b>Credits</b>   | :  | <b>3</b>   |
| <b>Pre-requisite:</b>  |  |  |
| Basic knowledge on the animals living in different habitats          |  |  |
| <b>Expected Course Outcome:</b>                                      |  |  |
| On the successful completion of the course, student will be able to: |  |  |
| 1.   | Understand the structure and functions of various systems in animals                             | <b>K2 &amp; K4</b>                                   |
| 2.   | Learn the adaptive features of different groups of animals                                       | <b>K1 &amp; K2</b>                                   |
| 3.   | Learn the mounting techniques  | <b>K2 &amp; K3</b>                                   |
| 4.   | Acquire strong knowledge on the animal skeletal system   | <b>K2 &amp; K4</b>                                   |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

**INVERTEBRATES**

**Dissection**

|              |   |
|--------------|---|
| Earthworm    | : Nervous system                                      |
| <i>Sepia</i> | : Nervous & Digestive system                          |
| Cockroach    | : Digestive, Nervous, Reproductive & Mouth Parts      |
| Grasshopper  | : Digestive system and mouth parts (Voucher specimen) |
| Prawn        | : Appendages, nervous and digestive systems           |

**Study of the following slides with special reference to their salient features and their modes of life**

1. *Amoeba*
2. *Entamoeba histolytica*
3. *Paramecium*
4. *Hydra* with bud
5. Sporocyst – Liver fluke
6. *Cercaria* larva

7. *Tape worm (Scolex)*
8. *Ascaris T. S.*
9. Mysis of prawn

#### **Spotters**

1. Scorpion
2. *Penaeus indicus*
3. *Emerita (Hippa)*
4. *Perna viridis*

#### **Mounting**

- |             |   |             |
|-------------|---|-------------|
| Earthworm   | : | Body setae  |
| <i>Pila</i> | : | Radula      |
| Cockroach   | : | Mouth parts |
| Grasshopper | : | Mouth parts |

## **CHORDATES**

#### **Study the nervous system of Indian dog shark - Dissection**

1. Nervous system of Rat/Mouse
2. Cranial Nerves of Rat/Mouse
3. Facial Nerves of Rat/Mouse

#### **Study of the following specimens with special reference to their salient features and their modes of life**

1. *Amphioxus* sp. (Lancelet)
2. *Ascidia* sp. (sea squirt)
3. *Scoliodon laticaudatus* (Indian dog shark)
4. *Trygon* sp. (Sting ray)
5. *Torpedo* sp. (Electric ray)
6. *Arius maculatus* (Cat fish)
7. *Belone cancila* (Flute fish)
8. *Exocoetus poecilopterus* (Flying fish)
9. *Mugil cephalus* (Mullet)
10. *Tilapia mossambicus* (Tilapia)
11. *Rachycentron canadum* (Cobia)
12. *Tetrodon punctatus* (Puffer fish)
13. *Dendrophis* sp. (Tree snake)

#### **Study of the different types of scales in fishes**

1. Cycloid scale
2. Ctenoid scale
3. Placoid scale

#### **Study of the frog skeleton system (Representative samples)**

1. Entire skeleton
2. Skull
3. Hyoid apparatus
4. Pectoral girdle and sternum
5. Pelvic girdle
6. Fore limb
7. Hind limb

#### **Mounting**

1. Weberian ossicles of fish

**Text Books:**

1. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.
2. Iuliis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp-416.
3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528
4. CPCSEA Guidelines ([https://org.iisc.ac.in/wp-content/uploads/2020/11/SOP\\_CPCSEA\\_inner\\_page.pdf](https://org.iisc.ac.in/wp-content/uploads/2020/11/SOP_CPCSEA_inner_page.pdf))

**Reference Books:**

1. Preeti, G., and C. Mridula, 2000. Modern Experimental Zoology, Indus International Publication.
2. Sinha, J., A. K. Chatterjee, P. Chattopadhyaya. 2011. Advanced Practical Zoology, Arunabha Sen Publishers, pp-1070.

| Mapping with Programme Outcomes* |     |     |     |     |     |     |     |     |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| COs                              | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1                              | S   | S   | S   | M   | S   | S   | M   | S   | M   | S    |
| CO2                              | S   | M   | L   | S   | M   | S   | M   | M   | M   | M    |
| CO3                              | M   | M   | L   | S   | L   | S   | M   | L   | M   | M    |
| CO4                              | S   | S   | L   | S   | L   | S   | M   | L   | M   | L    |
| CO5                              | S   | S   | M   | L   | M   | S   | M   | S   | M   | M    |

\*S - Strong; M - Medium; L – Low



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**M.Sc. Zoology Course - SEMESTER-I**  
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### BIOLOGICAL CHEMISTRY

**Elective Paper-I**

**Paper Code: 23UPZOO1E01**

**Total Contact Hours: 90**

**Credits: 3**

**Weekly Contact Hours: 4**

|  |  |                             |
|--|--|-----------------------------|
| <b>Course Objectives:</b>  |  |                             |
| The main objectives of this course are:  |  |                             |
| 1.   | Students should know the fundamentals of biochemistry  |                             |
| <b>Course</b>  | :  | <b>Elective-I</b>           |
| <b>Course title</b>  | :  | <b>Biological Chemistry</b> |
| <b>Credits</b>   | :  | <b>3</b>                    |
| <b>Pre-requisite:</b>  |  |                             |
| Understanding fundamental properties of elements, atoms, molecules, chemical bonds, linkages and structure, composition, metabolism and functions of biomolecules. |  |                             |
| <b>Expected Course Outcome:</b>  |  |                             |
| On the successful completion of the course, student will be able to:   |  |                             |
| I  | Learn the structure, properties, metabolism and bioenergetics of biomolecules  | <b>K1 &amp; K3</b>          |
| II   | Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation                                | <b>K1 &amp; K2</b>          |
| III  | Understand the fundamentals of biophysical chemistry and biochemistry, importance and applications of methods in conforming the structure of biopolymers | <b>K2 &amp; K3</b>          |
| IV   | Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids  | <b>K2 &amp; K4</b>          |
| V  | Familiarize the use of methods for the identification, characterization and conformation of biopolymer structures  | <b>K5 &amp; K6</b>          |

**K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create**

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | Basics of biophysical chemistry and biochemistry: Structure and models of atoms, molecules and chemical bonds - Principles of biophysical chemistry (pH, buffer, Henderson–Hasselbalch equation reaction kinetics, thermodynamics, colligative properties).                            |
| <b>II</b>    | Biomolecular interactions and their properties: Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc. - Composition, structure, metabolism and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). |
| <b>III</b>   | Bioenergetics and enzymology: Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers - Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes               |
| <b>IV</b>    | Structural conformation of proteins and nucleic acids: Conformation of proteins (Ramachandran plot, secondary, tertiary and quaternary structure; domains; motifs and folds) - Conformation of nucleic acids (A-, B-, Z-DNA),  |

|  |  |
|--|--|
|  | t-RNA, micro-RNA).   |
| <b>V</b>   | Stabilizing interactions in biomolecules: Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage. |
| <b>Reading list</b>  |  |
| <ol style="list-style-type: none"> <li>1. Berg, J. M., J. L. Tymoczko and L. Stryer 2012. Biochemistry. 5th Ed., W.H. Freeman &amp; Co., New York, pp-1050.</li> <li>2. Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.</li> <li>3. McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7th Edition). Oxford University Press, US, pp-793.</li> <li>4. Nelson D.L. and M.M. Cox. 2018. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.</li> <li>5. Satyanarayana U. and U. Chakrapani, 2020. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.</li> </ol> |  |
| <b>Recommended texts</b>   |  |
| <ol style="list-style-type: none"> <li>1. Buchanan, B.B., W. Grissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp-1280.</li> <li>2. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), The McGraw-Hill Companies, Inc., USA, pp-704.</li> <li>3. Palmer, T. 2004. Enzymes. Affiliated East-West Press Pvt. Ltd., New Delhi, pp-416.</li> <li>4. Voet D. and J.G. Voet. 2019. Biochemistry. (6th Edition). John Wiley &amp; Sons (Asia) Pvt. Ltd., pp-1428.</li> </ol>  |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | M          | S          | M          | S          | L          | S          | M          | S          | M          | M           |
| <b>CO2</b>                              | S          | S          | L          | S          | S          | S          | M          | M          | M          | S           |
| <b>CO3</b>                              | M          | M          | M          | S          | M          | S          | S          | S          | S          | L           |
| <b>CO4</b>                              | S          | M          | S          | M          | S          | M          | S          | S          | S          | M           |
| <b>CO5</b>                              | M          | S          | S          | M          | M          | S          | M          | L          | S          | M           |

\*S - Strong; M - Medium; L-Low



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**M.Sc. Zoology Course - SEMESTER-I**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

### MICROBIOLOGY

**Elective Paper-2**

**Paper Code: 23UPZOO1E02**

**Total Contact Hours: 90**

**Credits: 3**

**Weekly Contact Hours: 4**

|  |   |                     |
|--|---|---------------------|
| <b>Course Objectives:</b>  |   |                     |
| The main objectives of this course are:  |   |                     |
| <ul style="list-style-type: none"> <li>➤ To provide students with the latest information in microbiological methods.</li> <li>➤ To provide advanced knowledge, understanding, and critical judgment about the profession in microbiology.</li> <li>➤ Acquire knowledge on the culture, isolation and control of microorganisms</li> <li>➤ Learn the food preservation techniques and study microbes in food and water</li> </ul> |   |                     |
| <b>Course</b>  | :   | <b>Elective-I</b>   |
| <b>Course title</b>  | :   | <b>Microbiology</b> |
| <b>Credits</b>   | :   | <b>3</b>            |
| <b>Pre-requisite:</b>  |   |                     |
| Basic knowledge on microbes and microbial diseases   |   |                     |
| <b>Expected Course Outcome:</b>  |   |                     |
| On the successful completion of the course, student will be able to:   |   |                     |
| I  | Able to recall the relationship of infections to symptoms, relapse and the accompanying pathology.  | <b>K1 &amp; K3</b>  |
| II   | To develop a heightened sense of understanding in students about the microscopic world around them.   | <b>K1 &amp; K4</b>  |
| III  | To understand and apply the physical and chemical control measure, explains mode of action of antibiotics and lists the microbial diseases in farm animals. | <b>K6 &amp; K5</b>  |

**K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create**

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | <b>History and Scope of Microbiology:</b> Wittaker's Five Kingdom concept- Bergy's manual on determinative bacteriology Difference between prokaryotic and eukaryotic microorganisms. A cellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance. |
| <b>II</b>    | <b>Culture and Characterization:</b> Isolation and identification of bacteria. Techniques of pure culture methods. Phases of growth. Microbial control – Physical and chemical agents Methods of sterilization and disinfection. Staining: Simple and differential staining; Gram staining; acid fast staining; negative staining; endospore staining; capsule staining and flagella staining.                       |
| <b>III</b>   | <b>Microbial genetics:</b> Methods of genetic transfers – transformation, conjugation, transduction. Mutations and mutagenesis: Types of Mutations; Physical, chemical & biological mutagens; Uses of mutations. Selective mutation strain improvement. Microbial Genomics: Genome project of <i>Escherichia coli</i> and <i>Yeast</i> . Metagenomics concepts and   |



|  |  |
|--|--|
|  | Significance   |
| <b>IV</b>  | <b>Host pathogen interaction:</b> Definitions - Infection, Invasion, Pathogen, Pathogenicity, Virulence, Toxigenicity, Carriers and their types, Opportunistic infections, Nosocomial infections. Transmission of infection. Bacterial diseases - Tuberculosis, Plague, Anthrax. Fungal diseases - Candidiasis, <i>Epidermaphyton floccosum</i> , <i>Tricophyton rubrum</i> . Viral diseases - Rabies, Dengue, AIDS, Influenza, Corona, swine flu, Chikungunya. Protozoan diseases - Amoebiasis and Malaria. |
| <b>V</b>   | <b>Industrial microbiology:</b> Microbial fermentation Microbial production of Antibiotics: penicillin, streptomycin, Vitamin B12 Vaccines - genetic recombinant vaccines. Bioremediation- Principles and applications.  |
| <b>Reading list</b>  |  |
| 1. Pelczar M J, Chan ECS and Kreig NR (2020) Microbiology. Tata-McGraw Hill.   |  |
| <b>Recommended texts</b>   |  |
| <ol style="list-style-type: none"> <li>1. Atlas RM (2015) Principles of Microbiology. 2<sup>nd</sup> edition, McGraw-Hill.</li> <li>2. Dubey RC and Maheswari DK (2018) Textbook of Microbiology. S. Chand and Co.</li> <li>3. Prescott LM (2016) Microbiology. 6<sup>th</sup> Edition. McGraw-Hill.</li> <li>4. Stanier R, Ingraham J, Wheelis M and Painter P (2014) General Microbiology. 5<sup>th</sup> Edition, Macmillan Press.</li> <li>5. Kathleen Park Talaro and Barry Chess Foundations in Microbiology 10<sup>th</sup> Edition. 2018 Mc Graw Hill Education Publishers, USA.</li> <li>6. Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology: An Introduction, 12th Edition (2017) Pearson publishers, USA</li> </ol> |  |

| Mapping with Programme Outcomes* |     |     |     |     |     |     |     |     |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| COs                              | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1                              | L   | L   | L   | L   | S   | S   | S   | M   | M   | M    |
| CO2                              | M   | M   | M   | S   | S   | S   | S   | M   | S   | M    |
| CO3                              | S   | S   | S   | M   | M   | S   | M   | M   | L   | S    |
| CO4                              | M   | M   | S   | L   | S   | S   | L   | M   | S   | S    |
| CO5                              | S   | M   | M   | S   | S   | S   | S   | M   | S   | S    |

\*S - Strong; M - Medium; L - Low



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**M.Sc. Zoology Course - SEMESTER-II**  
(This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**LAB COURSE II**  
(Biochemistry and Microbiology)

**Elective Practical**

**Paper Code: 23UPZOO1L02**

**Total Contact Hours: 723**

**Credits: 2**

**Weekly Contact Hours: 4**

|  |  |   |
|--|--|---|
| <b>Course Objectives:</b>  |  |   |
| The main objectives of this course are:                              |  |   |
| 1.   | To learn biochemistry and microbiology practicals.                 |   |
| 2.   | To have hands on experience in handling of biomacromolecules.      |   |
| 3.   | To study the significance of microbial organisms                   |   |
| <b>Course</b>  | :  | <b>Elective</b>                                     |
| <b>Course title</b>  | :  | <b>Lab Course-II: Biochemistry and Microbiology</b> |
| <b>Credits</b>   | :  | <b>2</b>  |
| <b>Pre-requisite:</b>  |  |   |
| Theoretical knowledge in biological science.                         |  |   |
| <b>Expected Course Outcome:</b>                                      |  |   |
| On the successful completion of the course, student will be able to: |  |   |
| 1.   | Students will learn estimation of glucose in human blood.          | <b>K2, K3 &amp; K4</b>                              |
| 2.   | Students will learn microbial culture techniques.                  | <b>K2 &amp; K3</b>                                  |
| 3.   | Students will learn antibacterial and antifungal activity testing. | <b>K2 &amp; K3</b>                                  |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

**BIOCHEMISTRY**

1. Preparation of buffers and pKa value determination
2. Principles and Laws of Spectrophotometric Methods
3. Estimation of Blood sugar Post prandial for students and teachers (Glucometer)
4. Estimation of Glucose (Anthrone method)
5. Effect of temperature and pH on amylase activity of your saliva. Tabulate the data of your Class students and teachers. Compare Diabetic and non-diabetic individual's.
6. Isolation, estimation (Spectrophotometric) and separation of proteins (SDS-PAGE)
7. Isolation, estimation (260/280nm UV-Vis-Spectrophotometric) and separation of DNA (AGE)
8. Thin layer Chromatographic separation of secondary metabolites/ lipids/fatty acids and RF value determination.
9. Molecular Docking protein- ligand interaction (using free online software)

**10. Spotters :**

UV-Visible Spectrophotometer, Agarose gel electrophoretic apparatus, Poly acrylamide Gel Electrophoretic Apparatus, Glucometer, Thin layer Chromatographic apparatus, Laminar air flow chamber, Sterilization units, pH meter, Light and Fluorescent microscopes

**Biochemical Disorders**

Adrenoleukodystrophy.

Diabetes, type 1.  
 Gaucher disease.  
 Hereditary hemochromatosis.  
 Lesch-Nyhan syndrome.  
 Maple syrup urine disease.  
 Menkes syndrome

MICROBIOLOGY

1. Methods of sterilization and Media Preparation
2. Pure Culture methods for Bacterium
3. Isolation, culture and identification of human / air / soil borne bacteria
4. Isolation, culture and identification of fungi from rotten vegetables
5. Identification of Gram+ve and Gram -Ve bacteria – Differential staining technique
6. Antibacterial activities testing
7. Anti-fungal activities testing
8. Isolation, culture and identification of gut-micro-biome of insects
9. Isolation, culture and identification of microbial flora of cow dung
10. Antibacterial activities of synthesized silver nanoparticles

| Mapping with Programme Outcomes* |     |     |     |     |     |     |     |     |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| COs                              | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1                              | S   | S   | S   | M   | S   | S   | M   | S   | M   | S    |
| CO2                              | S   | M   | L   | S   | M   | S   | M   | M   | M   | M    |
| CO3                              | M   | M   | L   | S   | L   | S   | M   | L   | M   | M    |
| CO4                              | S   | S   | L   | S   | L   | S   | M   | L   | M   | L    |
| CO5                              | S   | S   | M   | L   | M   | S   | M   | S   | M   | M    |

\*S - Strong; M - Medium; L – Low



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**M.Sc. Zoology Course - SEMESTER-I**  
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### BIostatISTICS

**Elective Paper-3**

**Paper Code: 23UPZOO1E03**

**Total Contact Hours: 90**

**Credits: 3**

**Weekly Contact Hours: 4**

|   |  |                      |
|---|--|----------------------|
| <b>Course Objectives:</b>   |  |                      |
| The main objectives of this course are:   |  |                      |
| 1.  | Students should know basic concepts in Biostatistics.  |                      |
| <b>Course</b>   | :  | <b>Elective-II</b>   |
| <b>Course title</b>   | :  | <b>Biostatistics</b> |
| <b>Credits</b>  | :  | <b>3</b>             |
| <b>Pre-requisite:</b>   |  |                      |
| Students should be aware of importance of analysis of quantitative and qualitative information from biological studies. |  |                      |
| <b>Expected Course Outcome:</b>   |  |                      |
| Upon completion of this course, Students would have   |  |                      |
| I   | Clear understanding of design and application of biostatistics relevant to experimental and population studies.  | <b>K2 &amp; K3</b>   |
| II  | Acquired skills to perform various statistical analyses using modern statistical techniques and software.  | <b>K3 &amp; K4</b>   |
| III   | Knowledge on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate statistical design/ methods of analysis. | <b>K5 &amp; K6</b>   |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | Scope and application of statistics; Primary and secondary data: Source and implications; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency, distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart. |
| <b>II</b>    | Measures of central tendency: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error and coefficient of variation.   |
| <b>III</b>   | Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.  |
| <b>IV</b>    | Hypothesis testing: Student 't' test – one sample, paired sample and independent sample 't' tests. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Regression analysis: Significance test for correlation coefficients. Computation of biological data, calculation of regression co-efficient, graphical representation and prediction.  |
| <b>V</b>     | Analysis of Variance: one way and two way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS).  |

| <b>Reading list</b>      |  |
|--------------------------|--|
| 1.                       | Arora, P. N. and P. K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp-447.   |
| 2.                       | Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp-407.  |
| 3.                       | Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp-363.  |
| 4.                       | Palanichamy, S. and Manoharan, M. 1990. Statistical Methods for Biologists, Palani Paramount Publications, Tamil Nadu, pp-264.                             |
| 5.                       | Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660.  |
| <b>Recommended texts</b> |  |
| 1.                       | Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp-48.  |
| 2.                       | Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467.   |
| 3.                       | Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp-859. |
| 4.                       | Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.                                      |
| 5.                       | Wayne W. Daniel. Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons Inc, USA, pp-443.                                      |
| 6.                       | Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp-593.                              |
| 7.                       | Pagano, M. and K. Gauvreau. 2008. Principles of Biostatistics (Second Edition), Cengage Learning, New Delhi, pp-525.                                       |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | M          | L          | M          | S          | S          | M          | S          | M          | M           |
| <b>CO2</b>                              | S          | S          | S          | S          | S          | S          | S          | S          | S          | S           |
| <b>CO3</b>                              | M          | S          | S          | S          | S          | S          | S          | S          | S          | L           |
| <b>CO4</b>                              | M          | M          | S          | L          | M          | M          | M          | S          | L          | M           |
| <b>CO5</b>                              | M          | M          | S          | L          | M          | S          | M          | L          | S          | M           |

\*S - Strong; M - Medium; L- Low



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**M.Sc. Zoology Course - SEMESTER-I**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

### ADVANCED TECHNIQUES IN ZOOLOGY

**Elective Paper-4**

**Paper Code: 23UPZOO1E04**

**Total Contact Hours: 72**

**Credits: 3**

**Weekly Contact Hours: 4**

|   |   |                                       |
|---|---|---------------------------------------|
| <b>Course Objectives:</b>   |   |                                       |
| The main objectives of this course are:   |   |                                       |
| 1. To gain knowledge about the mechanism of advanced instruments in Zoology<br>2. To understand the importance of ethics in research work<br>3. To impart the knowledge on gene cloning and DNA Microarray technologies |   |                                       |
| <b>1.</b>   | Students should know advanced techniques in Zoology           |                                       |
| <b>Course</b>   | :   | <b>Elective-II</b>                    |
| <b>Course title</b>   | :   | <b>Advanced Techniques in Zoology</b> |
| <b>Credits</b>  | :   | <b>3</b>                              |
| <b>Pre-requisite:</b>   |   |                                       |
| Students should be aware of various techniques in Zoological Science.   |   |                                       |
| <b>Expected Course Outcome:</b>   |   |                                       |
| Upon completion of this course, Students would be   |   |                                       |
| I   | Able to explain the composition and responsibilities of IAEC. | <b>K2 &amp; K3</b>                    |
| II  | Knowing the working principles of GC-MS and MS-MS.            | <b>K3 &amp; K4</b>                    |
| III   | Gain overall knowledge about advances in Zoological research. | <b>K5 &amp; K6</b>                    |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | <b>Scope of Zoological research:</b> Agriculture, environment and health. Functions of CPCSEA/CPSEA. Guide lines of Institutional animal ethical committee, composition and responsibilities of <b>IAEC</b> . <b>Research ethics</b> in animal experiments. Procedure for maintenance of small mammals in <b>Animal House</b> . Role of experimental animal studies in Medical, Environmental and Agricultural Sustainability. |
| <b>II</b>    | <b>Molecular Spectroscopy:</b> Principle and applications of UV-Visible, Raman, NMR Spectroscopy and its types – XRD - Powder and crystal forms, Mass Spectrometry (MS), LC-MS, GC-MS, MS-MS, MALDI-TOF. Current Scenario of molecular spectroscopic Techniques.   |
| <b>III</b>   | <b>Physical Separation Techniques:</b> Separation methods - Centrifuges-Ultra, Cooling refrigerated, gradient centrifuges-Working principle and applications. Principle, methods and applications of SDS-PAGE, Immunoelectrophoresis & AGE.  |
| <b>IV</b>    | <b>Molecular characterization:</b> DNA finger printing, Blotting methods- southern and western blotting. DNA sequencing-Maxam-Gilbert, and Sanger methods. Next generation sequencing. RNAi technology and its applications.   |
| <b>V</b>     | <b>Gene cloning:</b> Cloning of Dolly & Fishes. Human cloning and its social and ethical impact, Organ on chip & its application. Animal cell culture techniques – 2 Dimensional and 3D cell culture. Tissue engineering. Impact of nanotechnology in animal sciences.   |

| <b>Reading list</b>      |  |
|--------------------------|--|
| 1.                       | Kannan S, Krishnan M, Thirumurugan R and Achiraman S (2012) Methods in Molecular Biology, UVN Publishers, India.   |
| 2.                       | Kannan S, and Kayalvizhi N (2022) Cell and Molecular biology-A Practical Approach, MJ Publishers, India.   |
| 3.                       | John M. Davis (2011) Animal Cell Culture: Essential Methods , John Wiley & Sons, Ltd.  |
| <b>Recommended texts</b> |  |
| 1.                       | R. Ian Freshney (2016) Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications. 7th Edition Wiley-Blackwell Publishers New York. |
| 2.                       | Michael Butler Animal Cell Culture and Technology (THE BASICS) 2003 Garland Science Taylor and Francis.  |
| 3.                       | K. Wilson & J.M. Walker, (2019) Principles and Techniques of Practical Biochemistry ELBS Publication 25th Edition.   |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | M          | L          | M          | S          | S          | M          | S          | M          | M           |
| <b>CO2</b>                              | S          | S          | S          | S          | S          | S          | S          | S          | S          | S           |
| <b>CO3</b>                              | M          | S          | S          | S          | S          | S          | S          | S          | S          | L           |
| <b>CO4</b>                              | M          | M          | S          | L          | M          | M          | M          | S          | L          | M           |
| <b>CO5</b>                              | M          | M          | S          | L          | M          | S          | M          | L          | S          | M           |

\*S - Strong; M - Medium; L- Low



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### CELL AND MOLECULAR BIOLOGY

**Core Paper-IV**

**Paper Code: 23UPZOO1C03**

**Total Contact Hours: 108**

**Credits: 5**

**Weekly Contact Hours: 6**

|  |   |                                   |
|--|---|-----------------------------------|
| <b>Course Objectives:</b>  |   |                                   |
| The main objectives of this course are:  |   |                                   |
| 1.   | To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.           |                                   |
| 2.   | To realize involvement of various cellular components in accomplishing cell division.   |                                   |
| 3.   | To enable a successful performance in cell biology component of CSIR-UGC NET.   |                                   |
| 4.   | To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.           |                                   |
| <b>Course</b>  | :   | <b>Core-IV (Theory)</b>           |
| <b>Course title</b>  | :   | <b>Cell and Molecular Biology</b> |
| <b>Credits</b>   | :   | <b>5</b>                          |
| <b>Pre-requisite:</b>  |   |                                   |
| Students should have knowledge of the basic cellular structures and their salient functions in prokaryotic and eukaryotic cells. |   |                                   |
| <b>Expected Course Outcome:</b>  |   |                                   |
| Upon completion of this course, students could   |   |                                   |
| 1.   | Understand the general concepts of cell and molecular biology.  | <b>K2</b>                         |
| 2.   | Visualize the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance of molecular and cellular structures influencing functional features. | <b>K1 &amp; K2</b>                |
| 3.   | Perceive the importance of physical and chemical signals at the molecular level resulting in modulation of response of cellular responses.                              | <b>K3 &amp; K4</b>                |
| 4.   | Updated the knowledge on the rapid advances in cell and molecular biology for a better understanding of onset of various diseases including cancer.                     | <b>K5</b>                         |
| 5.   | Understand the general concepts of cell and molecular biology.  | <b>K2</b>                         |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | The Discovery of Cells, Basic Properties of Cells. Cell Theory, Basic structure of prokaryotic and eukaryotic cells, Protoplasm and deutroplasm, Viruses and Viroids, Cell Organelles: The ultra-structure and functions of Plasma Membrane -The Chemical Composition of Membranes - Membrane Proteins-Membrane Lipids and Membrane Fluidity-The Dynamic Nature of the Plasma Membrane, The Movement of Substances across Cell Membranes. Ultra structure of Cell Wall. Diversity of cell size and shapes. |



|   |  |
|---|--|
| <b>II</b>   | Ion Transport: Types: Active Transport, Role of ATPase in ion Transport, Passive Transport- Types: Simple Diffusion and Facilitated Diffusion – Antiport, Symport and uniport- Mechanism of ion transport and Biological importance. Biology of Osmosis, ATP dependent Calcium Channel and its biological significance. Types of Vesicle Transport: Extracellular Vesicles for Drug Delivery, Mechanism of Endo and Exocytosis : Molecule Internalization and Recycling, Posttranslational Uptake of Proteins by Peroxisomes and Mitochondria, Structure and functions of Intracellular organelles: Nucleus Lysosome, Mitochondria, Endoplasmic reticulum, Golgi bodies, Ribosomes, Flagella and Cilia   |
| <b>III</b>  | The Discovery of Chromosomes and Chromatin. Chromosomes as a Carrier of Genetic Information, The Complexity of the Genome, Cell division types and their Significance, Mitosis-stages, importance of mitotic spindle formation. Meiosis – meiotic stages- structure and functions of synaptonemal complex. Cell Cycle: Phases and their molecular events- cyclin and cyclin dependent kinases. Biological significance of cell cycle checks points. The Central Dogma of Life: DNA to RNA to Protein, Structure and types of DNAs and RNAs. DNA replication: Types and Mechanism. Transcription in Prokaryotic and Eukaryotic Cells. Post transcriptional modifications (RNA splicing). Translation in prokaryotic and eukaryotic cells and Posttranslational Control.   |
| <b>IV</b>   | The Basic Elements of Cell Signaling Systems and their types, A Survey of Extracellular Messengers and Their Receptors, Membrane- associated receptors for peptide and steroid hormones – signaling through G-protein coupled receptors, Signal transduction pathways. Protein-Tyrosine Phosphorylation as a Mechanism for Signal Transduction, General principles of cell communication: extracellular space and matrix, Interaction of cells with other cells and non-cellular structures. The Role of Calcium as an Intracellular Messenger Convergence, Divergence, and Cross-Talk among Different Signaling Pathways. The Role of Nitrous Oxide as an Intracellular Messenger, Signal Transduction Pathways in Lymphocyte Activation. Cellular and Molecular Basis of Immunity and Significance of Adoptive T-cell Therapy. |
| <b>V</b>  | Cancer cells: Basic Properties of a Cancer Cell, Comparison of normal and cancer cells. Metastasis and malignancy and their pathophysiological effects, Oncogenes: Growth factors, Signal Transducers and Transcription factors. Tumor suppressor genes: p53, PTEN, BRCA1, APC and Rb genes and their action, Apoptosis – Types and mechanisms. Diagnosis of Cancer: Biochemical- MTT Assay, Cell Viability BrUd Assay, Microscopic staining techniques: DAPI, Ao/EtBr, Hoechst and Molecular Detection- DNA Fragmentation Assay Western Blotting and Flow Cytometry. Therapeutic interventions of Cancer- Chemo Therapy, Nano Conjugated Drugs, Immunotherapy, and Monoclonal antibody based cancer therapy, Stem Cell Biology: An over view of Stem Cells and Cancer stem cells.   |
| <b>Reading list</b>   |  |
| <ol style="list-style-type: none"> <li>1. Karp, G. 2016. Cell Biology (8<sup>th</sup> Edition), John Wiley &amp; Sons, Singapore, pp-765.</li> <li>2. Lodish, H., C. A. Kaiser, A. Bretscher, <i>et al.</i>, 2019. Molecular Cell Biology (10<sup>th</sup> Edition), Macmillan, England, pp-1154</li> <li>3. De Robertis, E.D.P. and E. M. F. De Robertis Jr, 2017. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734.</li> <li>4. Alberts, B., A. Johnson, J. Lewis, <i>et al.</i>, 2020, Molecular Biology of the Cell (Sixth Edition), Garland Science, New York, pp-1342</li> </ol>   |  |
| <b>Suggested Sources for Advance Readings</b>   |  |
| <ol style="list-style-type: none"> <li>I. <u>Link: <a href="https://www.ncbi.nlm.nih.gov/books/NBK13714/">https://www.ncbi.nlm.nih.gov/books/NBK13714/</a></u></li> <li>II. <u>Journals: Science, Nature Cell Biology, Lancet: Oncology</u></li> <li>III. <u>Books:</u> <ol style="list-style-type: none"> <li>1. G.M. Cooper and R.E.Hausman, 2018. The Cell: A Molecular Approach.</li> <li>2. Gerald Karp, 2013. Cell Biology, 7<sup>th</sup> Edition, Wiley Publication</li> <li>3. Daniel D. Karp, Gerald S. Falchook, JoAnn D. Lim, 2022. Handbook of Targeted Cancer Therapy and Immunotherapy, 3<sup>rd</sup> Edition, Wolters Kluwer Health Publication.</li> </ol> </li> <li>IV. <u>e.Books/ databases links</u> <ol style="list-style-type: none"> <li>1. <a href="https://www.freebookcentre.net/Biology/Cell-Biology-Books.html">https://www.freebookcentre.net/Biology/Cell-Biology-Books.html</a></li> <li>2. <a href="https://open.umn.edu/opentextbooks/textbooks/244">https://open.umn.edu/opentextbooks/textbooks/244</a></li> <li>3. <a href="https://www.ncbi.nlm.nih.gov/books/NBK21054/?term=molecular%20biology%20of%20the%20cell%20alberts">https://www.ncbi.nlm.nih.gov/books/NBK21054/?term=molecular%20biology%20of%20the%20cell%20alberts</a></li> <li>4. <a href="https://www.ncbi.nlm.nih.gov/books/NBK19662/?term=Cell%20Biology">https://www.ncbi.nlm.nih.gov/books/NBK19662/?term=Cell%20Biology</a></li> <li>5. <a href="https://www.ncbi.nlm.nih.gov/books/NBK9839/?term=Cell%20Biology">https://www.ncbi.nlm.nih.gov/books/NBK9839/?term=Cell%20Biology</a></li> </ol> </li> </ol> |  |

6. <https://www.ncbi.nlm.nih.gov/genome/guide/human/>
7. <https://www.proteinatlas.org/>
8. <https://www.ebi.ac.uk/gxa/home>

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | L          | L          | S          | S          | S          | M          | M          | M           |
| <b>CO2</b>                              | M          | S          | M          | S          | S          | S          | S          | M          | S          | M           |
| <b>CO3</b>                              | S          | S          | S          | M          | S          | S          | M          | M          | L          | S           |
| <b>CO4</b>                              | M          | M          | S          | S          | S          | S          | S          | M          | S          | S           |
| <b>CO5</b>                              | S          | M          | M          | S          | S          | S          | S          | M          | S          | S           |

\*S - Strong; M - Medium; L - Low



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### DEVELOPMENTAL BIOLOGY

**Core Paper-V**

**Paper Code: 23UPZOO1C04**

**Total Contact Hours: 108**

**Credits: 5**

**Weekly Contact Hours: 6**

|   |  |                              |
|---|--|------------------------------|
| <b>Course Objectives:</b>   |  |                              |
| The main objectives of this course are:                             |  |                              |
| 1.  | Understand the process of gametogenesis, cleavage and gastrulation, embryonic development, extra embryonic membrane and placenta in various animals and human. |                              |
| 2.  | Learn the principles, methods and applications of cryo-preservation of gametes and embryo.   |                              |
| <b>Course</b>   | :  | <b>Core-V (Theory)</b>       |
| <b>Course title</b>   | :  | <b>DEVELOPMENTAL BIOLOGY</b> |
| <b>Credits</b>  | :  | <b>5</b>                     |
| <b>Pre-requisite:</b>   |  |                              |
| Students have fundamental knowledge in developmental biology.       |  |                              |
| <b>Expected Course Outcome:</b>                                     |  |                              |
| On the successful completion of the course, student will be able to |  |                              |
| 1.  | Define the concepts of embryonic development   | <b>K1</b>                    |
| 2.  | Observe various stages of cell divisions under microscope  | <b>K2 &amp; K3</b>           |
| 3.  | Understand the formation of zygote   | <b>K4</b>                    |
| 4.  | Differentiate the blastula and gastrula stages   | <b>K4 &amp; K5</b>           |
| 5.  | Learn the distinguishing features of three different germ layers and formation of various tissues and organs   | <b>K4</b>                    |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>UNITS</b> |   |
|--------------|---|
| <b>I</b>     | Pattern of animal development: Chief events in animal development; History of thoughts and conceptual developments. Gametogenesis: Origin of germ cells, Seven Stages of Spermatogenesis - Sperm morphology in relation to the type of fertilization, Oogenesis - Oogenesis in insects and amphibians; Origin of stem cell and ovulation in mammals; Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians      |
| <b>II</b>    | Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitation in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg - Egg activation - Intracellular calcium release - Cortical reaction - Physiological polyspermy - Fusion of male and female pronuclei - Post fertilization metabolic activation – Parthenogenesis; Abnormality in fertilization- infertility, antifertility and organ dysfunction with reference to male and female gametes. |
| <b>III</b>   | Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition - Determinate and regulatory embryos, Factors affecting gastrulation, mechanisms and types of gastrulation in respective animal embryos (Sea urchin, <i>Amphioxus</i> , Amphibians, Aves, Mammals); Fate maps - (Amphibian and Chick),  |

|   |   |
|---|---|
|   | Epigenesis and preformation – Formation of primary germ layers. Isolation of stem cells from cleavage, Blastula and the concept of super ovulation  |
| <b>IV</b>   | Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Embryonic stem cells in modern medicine and super foetation. Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation; Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Gene and development; Anterior- posterior axis in determination in drosophila, Maternal effect genes - <i>Bicoid</i> and <i>Nanos</i> proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes   |
| <b>V</b>  | Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Formation of ectodermal cap and regeneration blastema – Types of regeneration in planaria, Regenerative ability in different animal groups, Factors stimulating regeneration – Biochemical changes associated with regeneration. Aging and senescences: Biology of senescences- cause of aging- mechanism involved in apoptosis. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Endocrine changes associated with normal pregnancy, Induced ovulation in humans – Cryopreservation of gametes/embryos - Ethical issues in cryopreservation – Artificial insemination – IUI – IVF Techniques. Synthetic human embryos and its applications and concept of twins' formation. |
| <b>Reading list</b>   |   |
| <ol style="list-style-type: none"> <li>Balinsky, B. I. 1981. Introduction to Embryology (5<sup>th</sup> Edition), CBS College Publishers, New York, pp-782.</li> <li>Gilbert. S. F. 2006. Developmental Biology, 8<sup>th</sup> Edition, INC Publishers, USA, pp-785.</li> <li>Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.</li> <li>Tyler, M.S. 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA, pp-208.</li> <li>Subramoniam, T. 2011. Molecular Developmental Biology (2<sup>nd</sup> Edition), Narosa Publishers, India, pp-364.</li> <li><a href="http://www.easybiologyclass.com">www.easybiologyclass.com</a> › developmental-biology-e</li> <li><a href="http://www.studocu.com">www.studocu.com</a> › document › lecture-notes › view</li> <li><a href="http://ocw.mit.edu">ocw.mit.edu</a> › courses › 7-22-developmental-biology-f.</li> </ol> |   |
| <b>Recommended texts</b>  |   |
| <ol style="list-style-type: none"> <li>Wilt, F.H. and N.K. Wessel. 1967. Methods in Developmental Biology, Thomas Y Crowell, New York.</li> <li>Slack J.M.W. 2012. Essential Developmental Biology (3<sup>rd</sup> Edition), Wily-Blackwell Publications, USA, pp-496.</li> <li>Mari-Beffa, M. and J. Knight. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.</li> </ol>  |   |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | S          | S          | L          | S          | M          | L          | M           |
| <b>CO2</b>                              | S          | S          | S          | S          | S          | L          | S          | S          | S          | S           |
| <b>CO3</b>                              | S          | M          | S          | S          | S          | S          | S          | L          | L          | M           |
| <b>CO4</b>                              | S          | S          | S          | S          | S          | M          | S          | S          | S          | L           |
| <b>CO5</b>                              | S          | S          | S          | M          | S          | S          | S          | L          | L          | M           |

\*S - Strong; M - Medium; L – Low



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**LAB COURSE III**  
**(CELL AND MOLECULAR BIOLOGY AND DEVELOPMENTAL BIOLOGY)**

**Core Paper-VI**

**Paper Code: 23UPZOO1L03**

**Total Contact Hours: 108**

**Credits: 3**

**Weekly Contact Hours: 6**

|   |  |   |
|---|--|---|
| <b>Course Objectives:</b>   |  |   |
| The main objectives of this course are:   |  |   |
| 1.  | Practical course aims at demonstrating significant cellular and molecular biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology, genetics and developmental biology into practical understanding. |   |
| <b>Course</b>   | :  | <b>Core-VI (Practical)</b>  |
| <b>Course title</b>   | :  | <b>Lab Course-III: Cell &amp; Molecular Biology and Developmental Biology</b> |
| <b>Credits</b>  | :  | <b>3</b>  |
| <b>Pre-requisite:</b>   |  |   |
| Students should have acquired basic knowledge relevant to this particular lab course. |  |   |
| <b>Expected Course Outcome:</b>   |  |   |
| Upon completion of this lab course, students  |  |   |
| 1.  | Acquire knowledge to differentiate the cells of various living organisms and become aware of physiological processes of cells e.g. cell divisions, various stages of fertilization and embryo development.   | <b>K2</b>   |
| 2.  | Understand and observe as well as correctly identify different cell types, cellular structures using different microscopic techniques.   | <b>K3</b>   |
| 3.  | Develop handling - skills through the wet-lab course.  | <b>K6</b>   |
| 4.  | Learn the method of culturing of <i>Drosophila</i> and identification of their wild and mutant strains   | <b>K1 &amp; K2</b>  |
| 5.  | Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities   | <b>K1 &amp; K2</b>  |

**K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create**

**CELL AND MOLECULAR BIOLOGY**

1. Determination of cell size using micrometer
2. Mitosis in root meristematic cells of plants
3. Identification of various stages of meiosis in the testes of grasshopper
4. Detection of polytene chromosome in salivary gland cells of the larvae of the *Chironomus*
5. Detection of sex chromatin
6. Identification of blood cells in the haemolymph of the cockroach
7. Isolation of genomic DNA from eukaryotic tissue
8. Isolation of total RNA from bacterial cells/tissues
9. Agarose gel electrophoresis of DNA
10. SDS-Polyacrylamide gel electrophoresis

## MICROBIOLOGY

1. Methods of sterilization and Media Preparation
2. Pure Culture methods for Bacterium
3. Isolation, culture and identification of human / air / soil borne bacteria
4. Isolation, culture and identification of fungi from rotten vegetables
5. Identification of Gram+ve and Gram –Ve bacteria – Differential staining technique
6. Antibacterial activities testing
7. Anti-fungal activities testing
8. Isolation, culture and identification of gut-micro-biome of insects
9. Isolation, culture and identification of microbial flora of cow dung
10. Antibacterial activities of synthesized silver nanoparticles

## DEVELOPMENTAL BIOLOGY

Gametogenesis - Observation of gametes from gonadal tissue sections

- i. Oogenesis:
  - ✓ Section through ovary of shrimp, fish, frog and mammals
- ii Spermatogenesis:
  - ✓ Section through testis of shrimp, fish, calotes and mammals

Fertilization

- iii Induced spawning in polychaete worm *Hydroids elegans*
- iv *In vitro* fertilization and development in a polychaete worm *Hydroids elegans*
- v Observation of egg developmental stages in *Emerita emeritus*

Embryogenesis

- vi Observation and whole mount preparation of the chick blastoderm - 18 hours of development
- vii Chick embryonic stage - 24 hours of development
- viii Chick embryonic stage - 48 hours of development
- ix Chick embryonic stage - 72 hours of development
- x Chick embryonic stage - 96 hours of development

Histological observation: Section through various developmental stages in chick embryo

Experimental Embryology

Regeneration in Frog Tadpoles

- xi Blastema formation
- xii Demonstration of regenerative process in tadpole

Metamorphosis

- xiii Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine

Cryopreservation

- xiv Demonstration of cryopreservation of gametes of fin fish/shell fish

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | M          | S          | S          | S          | S          | S          | L          | L          | M           |
| <b>CO2</b>                              | S          | S          | S          | S          | S          | M          | M          | M          | M          | M           |
| <b>CO3</b>                              | S          | S          | M          | S          | S          | L          | S          | M          | L          | M           |
| <b>CO4</b>                              | M          | M          | L          | M          | L          | M          | M          | S          | M          | L           |
| <b>CO5</b>                              | S          | S          | M          | L          | S          | M          | L          | S          | S          | S           |

\*S - Strong; M - Medium; L – Low



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### ECONOMIC ENTOMOLOGY

**Elective Paper-III**

**Paper Code: 23UPZOO1E05**

**Total Contact Hours: 72**

**Credits: 3**

**Weekly Contact Hours: 4**

|   |   |                            |
|---|---|----------------------------|
| <b>Course Objectives:</b>   |   |                            |
| The main objectives of this course are:   |   |                            |
| 1.  | Students should acquire a fairly good understanding about the life of insects and their classification.               |                            |
| <b>Course</b>   | :   | <b>Elective-III</b>        |
| <b>Course title</b>   | :   | <b>Economic Entomology</b> |
| <b>Credits</b>  | :   | <b>3</b>                   |
| <b>Pre-requisite:</b>   |   |                            |
| The students with a basic background in biological sciences with a special emphasis on the study of insects including systematic, beneficial insects, destructive insects, integrated pest management and insects of medical and veterinary importance. |   |                            |
| <b>Expected Course Outcome:</b>   |   |                            |
| On the successful completion of the course, student will be able to   |   |                            |
| I   | Understand taxonomy, classification and life of insects in the animal kingdom.  | <b>K1 &amp; K2</b>         |
| II  | Know the life cycle, rearing and management of diseases of beneficial insects.  | <b>K2 &amp; K3</b>         |
| III   | Know the type of harmful insects, life cycle, damage potential and management of pests including natural pest control | <b>K2 &amp; K3</b>         |
| IV  | Recognize insects which act as vectors causing diseases in animals and human.   | <b>K2 &amp; K4</b>         |
|   | Overall understanding on the importance of insects in human life.   | <b>K2 &amp; K6</b>         |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** -Create

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | Overview of insects and insect taxonomy & Morphology: Insects and their biological success Life cycle & development – Insect behaviour and ecology - Man and insects; Basic concepts in Insect Taxonomy and classification.  |
| <b>II</b>    | Beneficial insects: Silkworms - types, life history, disease management and rearing methods - Types of honey bees, life history, social organization (colonies and caste system), honey bee care and management of bee hive - Lac insects-life history, lac cultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil-builders. |
| <b>III</b>   | Destructive insects: Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Biology of the insect pests - Pests of paddy, cotton, sugarcane, vegetables, coconut and stored grains cereals.   |
| <b>IV</b>    | Pest management/Control strategies: Methods and principles of pest control - Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control -  |

|  |  |
|--|--|
|  | Development and uses of pest resistant plant varieties - Integrated pest management - Concepts and practice.                             |
| <b>V</b>   | Vector biology: Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures. |
| <b>Reading list</b>  |  |
| <ol style="list-style-type: none"> <li>1. Ayyar, L.V. R. 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi, pp- 528.</li> <li>2. Vasantharaj David, B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.</li> <li>3. Ross. H.H. 1965. A Text Book of Entomology, John Wiley &amp; Sons Inc., New York, pp-746.</li> </ol>  |  |
| <b>Recommended texts</b>   |  |
| <ol style="list-style-type: none"> <li>1. Chapman, R.F., S.J. Simpson and A.E. Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.</li> <li>2. Imms, A.D., O.W. Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.</li> <li>3. Daly, H.V., J.T. Doyen and P.R. Ehrlich. 1978. Introduction to Insect Biology and Diversity. Mc Graw-Hill Kogakusha Ltd., Tokyo, pp-564.</li> <li>4. Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.</li> <li>5. Krishnaswami, S. 1973. Sericulture Manual, Vol. I &amp; II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.</li> <li>6. Mani, M.S. 1982. General Entomology. Oxford &amp; IBH Publishing Co., pp-912.</li> <li>7. Wigglesworth, V.B. 1972. The Principles of Insect Physiology, ELBS &amp; Chapman and Hall, London, pp-827.</li> </ol> |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | M          | S          | M          | S          | M          | M          | M          | S          | L          | M           |
| <b>CO2</b>                              | S          | S          | M          | S          | S          | S          | S          | S          | S          | L           |
| <b>CO3</b>                              | S          | M          | S          | S          | S          | S          | S          | S          | S          | S           |
| <b>CO4</b>                              | S          | S          | S          | S          | S          | S          | M          | S          | M          | M           |
| <b>CO5</b>                              | S          | S          | S          | M          | M          | S          | M          | L          | S          | M           |

\*S - Strong; M - Medium; L-Low





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### MEDICAL PARASITOLOGY

**Elective Paper-III**

**Paper Code: 23UPZOO1E06**

**Total Contact Hours: 72**

**Credits: 3**

**Weekly Contact Hours: 4**

| <b>Course Objectives:</b>   |   |                             |
|---|---|-----------------------------|
| The main objectives of this course are:   |   |                             |
| 1.  | To gain basic understanding about Zoonotic Diseases and also impart knowledge on parasitic vectors.                             |                             |
| <b>Course</b>   | :   | <b>Elective-III</b>         |
| <b>Course title</b>   | :   | <b>Medical Parasitology</b> |
| <b>Credits</b>  | :   | <b>3</b>                    |
| <b>Pre-requisite:</b>   |   |                             |
| The students with a basic background in biological sciences with a special emphasis on the understanding about Zoonotic diseases including medically important human parasites. |   |                             |
| <b>Expected Course Outcome:</b>   |   |                             |
| On the successful completion of the course, student will be able to   |   |                             |
| I   | Students will get knowledge about the different types of Parasites and their transmission.                                      | <b>K1 &amp; K2</b>          |
| II  | Students will impart knowledge about the life cycle and control measures of various protozoan parasites causing human diseases. | <b>K2 &amp; K3</b>          |
| III   | Students will understand about the life cycle and control measures of various helminth parasites causing human diseases.        | <b>K2 &amp; K3</b>          |
| IV  | To know the life cycle of vectors, disease spread and control measures.   | <b>K2 &amp; K4</b>          |
| V   | Overall understanding on microbial zoonosis, their transmission, epidemiology and prevention.                                   | <b>K2 &amp; K6</b>          |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** -Create

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | Introduction to parasitism - Parasitic evasion of host defence - Pathology of parasitic infection - Types of parasites - Obligatory and facultative parasites - diversity of parasites - Mode of transmission of parasites  |
| <b>II</b>    | Protozoan parasites- Leishmaniasis- Amoebiasis- Morphology, biology, life cycle and control measures- - Malaria-types of malarial parasites-Sporogonic cycle- Exo-erythrocytic cycle – Endo-erythrocytic cycle- Vectors of malaria- control measures  |
| <b>III</b>   | Helminth parasites- Taeniasis- Life cycle and pathogenicity, transmission, preventive and control measures- morphology, biology, life-cycles, modes of entry of <i>Schistosoma</i> , <i>Wuchereria</i> - <i>Fasciola hepatica</i> , <i>Ascaris lumbricoides</i> - Life cycle - mode of transmission and control measures. |
| <b>IV</b>    | Vectors and Vector borne diseases- Mosquitoes and flies- <i>Culex</i> , <i>Anopheles</i> and <i>Aedes</i> - Life cycle- diseases spread and control measures- Diseases spread by Sand flies, fleas, ticks, mites, Crustaceans and their control.  |
| <b>V</b>     | Microbial zoonosis- Bacterial diseases- Plague, Salmonellosis, Anthrax, Tuberculosis-   |

|  |  |
|--|--|
|  | Viral diseases- AIDS, Rabies- SARS- Influenza - transmission-epidemiology and prevention – Emerging infectious diseases- Covid-19- Ebola- Nipah – preventive measures and treatment. |
| <b>Reading list</b>  |  |
| <ol style="list-style-type: none"> <li>1. Bhattacharya, D (2018) Text book of Parasitology, Wave books, New Delhi, India</li> <li>2. Bose, M. (2017) Parasitosis and Zoonosis, New central book agency, Kolkata, India</li> <li>3. Chatterjee, K. D., (2019) Parasitology Protozoology and Helminthology, CBS publishers, India</li> </ol>   |  |
| <b>Recommended texts</b>   |  |
| <ol style="list-style-type: none"> <li>1. Coleman, M. (2022) Human Parasitology, KAUFMAN PRESS, USA</li> <li>2. Ghosh, S. (2019) Paniker's Textbook of Medical Parasitology, Jaypee Brothers Medical Publishers, India</li> <li>3. Loker, E.S. &amp; Hofkin, B. V (2015) Parasitology: A conceptual approach, Garland Science, USA</li> <li>4. Riedel, S., Morse, S. A., Mietzner T. A., &amp; S. Miller (2019) Jawetz Melnick &amp; Adelbergs Medical Microbiology, McGraw Hill Publisher, India</li> <li>5. Shymasundry, K &amp; Rao, K. H. (2012) Medical parasitology, MJP publishers, Chennai, India</li> </ol> |  |

| Mapping with Programme Outcomes* |     |     |     |     |     |     |     |     |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| COs                              | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1                              | M   | S   | M   | S   | M   | M   | M   | S   | L   | M    |
| CO2                              | S   | S   | M   | S   | S   | S   | S   | S   | S   | L    |
| CO3                              | S   | M   | S   | S   | S   | S   | S   | S   | S   | S    |
| CO4                              | S   | S   | S   | S   | S   | S   | M   | S   | M   | M    |
| CO5                              | S   | S   | S   | M   | M   | S   | M   | L   | S   | M    |

\*S - Strong; M - Medium; L-Low



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### RESEARCH METHODOLOGY

**Elective Paper-IV**

**Paper Code: 23UPZOO1E07**

**Total Contact Hours: 72**

**Credits: 3**

**Weekly Contact Hours: 4**

|  |  |                             |
|--|--|-----------------------------|
| <b>Course Objectives:</b>  |  |                             |
| The main objectives of this course are:  |  |                             |
| 1.   | Students understand the basic principle, methodology and applications of widely used instruments in biological sciences. |                             |
| <b>Course</b>  | :  | <b>Elective-IV</b>          |
| <b>Course title</b>  | :  | <b>Research Methodology</b> |
| <b>Credits</b>   | :  | <b>3</b>                    |
| <b>Pre-requisite:</b>  |  |                             |
| Students should know the fundamentals of basic methods employed in experimental biology. |  |                             |
| <b>Expected Course Outcome:</b>  |  |                             |
| On the successful completion of the course, student will be able to                      |  |                             |
| 1.   | Understand the implications of GLP   | <b>K1</b>                   |
| 2.   | Learn the working principles of different instruments  | <b>K2</b>                   |
| 3.   | Gain the knowledge on techniques of histology and histochemistry   | <b>K2 &amp; K4</b>          |
| 4.   | Acquire knowledge on the basic principle and application of various modules of light and electron microscopy             | <b>K3 &amp; K5</b>          |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**- Create

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | CCSEA guidelines: IAEC Composition, Responsibilities of IAEC members, Establishment of Animal House - Strategies and Laws. Maintenance of Animal House - Dos and Don'ts. Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry. Microbiological Techniques - Media Preparation and sterilization - Inoculation and growth monitoring, Microbial identification |
| <b>II</b>    | Principle and applications of Histology, Histochemistry, Immunological techniques - Immunodiffusion (Single & Double) – Immuno electrophoretic Techniques, ELISA and its types, RIA. Bioinformatics: Primary and Secondary Databases of Protein and Nucleic Acids.  |
| <b>III</b>   | Principles and Applications of Light Microscopy, Bright field, Phase contrast, Differential interference Contrast (DIC) & Fluorescence microscopy and Confocal microscopy. Electron microscopy (FE-SEM & HR-TEM).   |
| <b>IV</b>    | Principle and applications of Centrifuges, Chromatography, principle type and application. Electrophoresis, Principles, types and applications -PAGE and agarose gel electrophoresis. Principle and Applications of Flow cytometry. Polymerase chain reaction (PCR), RT-PCR Blotting DNA Sequencing types and applications.   |
| <b>V</b>     | Principles and Applications of tracer techniques in biology. GM (Geiger-  |

|   |   |
|---|---|
|   | Muller) Counter, Scintillation Counter – Principle, Types, Description and Applications. Auto-radiography – Principle and applications. Animal cell culture techniques. Cell culture techniques. - Design and functioning of tissue culture laboratory - Culture media, essential components and Preparation - Cell viability testing and cell harvesting methods Cryopreservation of cells and tissues, freeze drying. |
| <b>Reading list</b>   |   |
| <ol style="list-style-type: none"> <li>1. Pearse, A.G. 1968. Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J &amp; A Churchill Ltd, pp-758.</li> <li>2. Lillie, R.D. 1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.</li> <li>3. Hoppert, M. 2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.</li> </ol>  |   |
| <b>Recommended texts</b>  |   |
| <ol style="list-style-type: none"> <li>1. Chandler, D.E. and Roberson R.W. 2009. Bioimaging: Current Concepts in Light and Electron Microscopy, Jones and Bartlet Publishers, Sudbury, MA, USA, pp440.</li> <li>2. Engelbert, B. 1960. Radioactive Isotopes in Biochemistry, Elsevier Applied Science, pp-376.</li> <li>3. Wolf, G. 1964. Isotopes in Biology, Academic Press, pp-173.</li> <li>4. Srivastava, B. B. 2005. Fundamentals of Nuclear Physics, Rastogi Publications, pp-500.</li> <li>5. Pantin, C. F. A. 1948. Microscopical Techniques, Cambridge University Press, London.</li> </ol> |   |

| Mapping with Programme Outcomes* |     |     |     |     |     |     |     |     |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| COs                              | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1                              | M   | S   | M   | S   | M   | S   | M   | S   | M   | M    |
| CO2                              | S   | S   | M   | S   | S   | S   | M   | M   | M   | S    |
| CO3                              | S   | M   | S   | S   | S   | S   | S   | S   | S   | L    |
| CO4                              | S   | S   | S   | S   | S   | M   | S   | S   | S   | M    |
| CO5                              | S   | S   | S   | M   | M   | S   | M   | L   | S   | M    |

\*S - Strong; M - Medium; L-Low



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### BIOETHICS AND BIOSAFETY

**Elective Paper-IV**

**Paper Code: 23UPZOO1E08**

**Total Contact Hours: 72**

**Credits: 3**

**Weekly Contact Hours: 4**

|  |   |                                |
|--|---|--------------------------------|
| <b>Course Objectives:</b>  |   |                                |
| The main objectives of this course are:  |   |                                |
| 1.   | Students should acquire a fairly good understanding about the life of insects and their classification.               |                                |
| <b>Course</b>  | :   | <b>Elective-IV</b>             |
| <b>Course title</b>  | :   | <b>Bioethics and Biosafety</b> |
| <b>Credits</b>   | :   | <b>3</b>                       |
| <b>Pre-requisite:</b>  |   |                                |
| This course helps to adhere to the ethical practices appropriate to the discipline at all times and to adopt safeworking practices relevant to the bioindustries & field of research |   |                                |
| <b>Expected Course Outcome:</b>  |   |                                |
| On the successful completion of the course, student will be able to  |   |                                |
| I  | Students will gain awareness about Intellectual Property Rights (IPRs) to take measure for the protecting their ideas | <b>K1 &amp; K2</b>             |
| II   | They will able to devise business strategies by taking account of IPRs  | <b>K2 &amp; K3</b>             |
| III  | They will be able to assist in technology upgradation and enhancing competitiveness.                                  | <b>K2 &amp; K3</b>             |
| IV   | They will acquire adequate knowledge in the use of genetically modified organisms and its effect on human health      | <b>K2 &amp; K4</b>             |
| V  | They will gain more insights into the regulatory affairs.   | <b>K2 &amp; K6</b>             |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** -Create

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | Biosafety: Introduction, Historical prospective, objectives, risk assessment in biotechnological research and their regulation, physical and biological contaminants, field trial and planned introduction of GMOs, Biosafety guidelines in India, Biosafety levels for animal and microbial researches.                |
| <b>II</b>    | Bioethics: Introduction, Ethical issues related to biotechnology, legal and socioeconomic impacts of biotechnology, health and safety issues, possible benefits of successful cloning, Ethical concerns of gene cloning, hazards of environmental engineering, Ethical issues in Human Cloning and stem cell research.  |
| <b>III</b>   | Intellectual Property Right: Introduction, intellectual property: trade secret, patent, copyright, patent law, Choice and management of IPRs, advantage and limitations of IPRs.  |
| <b>IV</b>    | Patents and patent processing: Introduction, Essential requirements, International scenario of patents, patenting of biological materials, significance of patents in India, Patent application, Procedures and granting, protection of biotechnological inventions, Patent Act (1970), Patent (Amendments) Act (2002). |
| <b>V</b>     | Regulatory framework in Biotechnology: Regulation of RDT research, Regulatory   |

|   |  |
|---|--|
|   | framework in India governing GMOs, Recombinant DNA Guidelines (1990), Revised Guidelines for Research in Transgenic ANIMALS (1998). Roles of Institutional Biosafety Committee, Ethical implications of biotechnological products and techniques. Social and ethical implications of biological weapons. |
| <b>Reading list</b>   |  |
| <ol style="list-style-type: none"> <li>1. Entrepreneurship: New Venture Creation : David H. Holt</li> <li>2. Patterns of Entrepreneurship : Jack M. Kaplan</li> <li>3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand &amp; Sons.</li> </ol>   |  |
| <b>Recommended texts</b>  |  |
| <ol style="list-style-type: none"> <li>1. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.</li> <li>2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.</li> <li>3. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.</li> <li>4. The law and strategy of Biotechnological patents by Sibley. Butterworth publications.</li> <li>5. Intellectual property rights – Ganguli – Tat McGraw-Hill</li> <li>6. Biotechnology-B. D. Singh- Kalyani Publications</li> </ol> |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | M          | S          | M          | S          | M          | M          | M          | S          | L          | M           |
| <b>CO2</b>                              | S          | S          | M          | S          | S          | S          | S          | S          | S          | L           |
| <b>CO3</b>                              | S          | M          | S          | S          | S          | S          | S          | S          | S          | S           |
| <b>CO4</b>                              | S          | S          | S          | S          | S          | S          | M          | S          | M          | M           |
| <b>CO5</b>                              | S          | S          | S          | M          | M          | S          | M          | L          | S          | M           |

\*S - Strong; M - Medium; L-Low



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### POULTRY FARMING

**Skill Enhancement Course (SEC) - I**

**Paper Code: 23UPZOO1S01**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|  |   |   |
|--|---|---|
| <b>Course Objectives:</b>  |   |   |
| The main objectives of this course are:  |   |   |
| 1.   | Students should know basic concepts in Vermiculture.  |   |
| <b>Course</b>  | :   | <b>Skill Enhancement Course (SEC) - I</b> |
| <b>Course title</b>  | :   | <b>Poultry Farming</b>                    |
| <b>Credits</b>   | :   | <b>2</b>                                  |
| <b>Pre-requisite:</b>  |   |   |
| Students should be aware of economic and cultural importance of Poultry farming. |   |   |
| <b>Expected Course Outcome:</b>  |   |   |
| Upon completion of this course, Students would have                              |   |   |
| I  | To understand the various practices in Poultry farming. To know the needs for Poultry farming and the status of India in global market. | <b>K2 &amp; K3</b>                        |
| II   | To be able to apply the techniques and practices needed or Poultry farming.   | <b>K1, K2 &amp; K3</b>                    |
| III  | To know the difficulties in Poultry farming and be able to propose plans against it.  | <b>K5 &amp; K6</b>                        |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| Units  |  |
|--|--|
| <b>I</b>   | General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming.        |
| <b>II</b>  | Management of chicks – Selection of egg for hatching - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance.   |
| <b>III</b>   | Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.  |
| <b>IV</b>  | Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.   |
| <b>V</b>   | Selection, care and handling of hatching eggs - Egg testing. Methods of hatching. Brooding and rearing -. Sexing of chicks. - Farm and Water Hygiene - Recycling of poultry waste – Economics of poultry farm. |
| <b>Reading list</b>  |  |
| 1. Sreenivasiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write & Print Publications, New Delhi 2.<br>2. Jull A. Morley, 2007. Successful Poultry Management. 2nd Edition. Biotech Books, New Delhi"<br>3. Hurd M. Louis, 2003. Modern Poultry Farming. 1st Edition. International Book Distributing Company, Lucknow."<br>4. Life and General Insurance Management"  |  |
| <b>Recommended texts</b>   |  |
| 1. <a href="http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf">http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf</a><br>2. <a href="https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf">https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf</a><br>3. <a href="http://ecoursesonline.iasri.res.in/course/view.php?id=335">http://ecoursesonline.iasri.res.in/course/view.php?id=335</a><br>4. <a href="https://swayam.gov.in/nd2_nou19_ag09/preview">https://swayam.gov.in/nd2_nou19_ag09/preview</a> |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | L          | L          | L          | L          | L          | S          | S          | L          | L           |
| <b>CO2</b>                              | S          | L          | M          | M          | S          | M          | M          | M          | S          | S           |
| <b>CO3</b>                              | S          | M          | M          | M          | S          | S          | S          | S          | M          | M           |
| <b>CO4</b>                              | S          | S          | S          | L          | S          | S          | S          | S          | S          | S           |
| <b>CO5</b>                              | S          | S          | M          | S          | S          | S          | M          | L          | S          | M           |

\*S - Strong; M - Medium; L – Low





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**SWAYAM COURSE**

**Non-Major Elective (NME) - I**

**Paper Code: 23UPZOO1N01**

**Total Contact Hours: Nil**

**Credits: 2**

**Weekly Contact Hours: Nil**

|  |   |                                     |
|--|---|-------------------------------------|
| <b>Course Objectives:</b>  |   |                                     |
| The main objectives of this course are:  |   |                                     |
| 1.   | Students should select a PG course in SWAYAM Portal with atleast 2 credits. |                                     |
| <b>Course I</b>  | <b>:</b>  | <b>Non-Major Elective (NME) - I</b> |
| <b>Course title</b>  | <b>:</b>  | <b>Swayam Course (Online)</b>       |
| <b>Credits</b>   | <b>:</b>  | <b>2</b>                            |
| <b>Expected Course Outcome:</b>  |   |                                     |
| Students should successfully complete atleast one online course through Swayam Portal. |   |                                     |



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### GENETICS

**Core Paper-VII**

**Paper Code: 23UPZOO1C05**

**Total Contact Hours: 90**

**Credits: 4**

**Weekly Contact Hours: 5**

| <b>Course Objectives:</b>   |   |                          |
|---|---|--------------------------|
| The main objectives of this course are:                             |   |                          |
| 1.  | Understanding DNA as genetic material, fine structure of DNA & RNA molecules, as well as physico-chemical properties of macromolecules. |                          |
| 2.  | Gain insight into sequential events occurs during protein synthesis.  |                          |
| 3.  | Learn the structure and function of chromosome and chromosomal basis of genetic disorders.  |                          |
| 4.  | To acquire knowledge about microbial genetics   |                          |
| 5.  | To provide information about rDNA technology and its application.   |                          |
| <b>Course</b>   | :   | <b>Core-VII (Theory)</b> |
| <b>Course title</b>   | :   | <b>GENETICS</b>          |
| <b>Credits</b>  | :   | <b>4</b>                 |
| <b>Pre-requisite:</b>   |   |                          |
| Basic knowledge on molecular biology and genetics                   |   |                          |
| <b>Expected Course Outcome:</b>                                     |   |                          |
| On the successful completion of the course, student will be able to |   |                          |
| 1.  | Explain the organization and functions of genetic material in the living system.  | <b>K1 &amp; K2</b>       |
| 2.  | Understand various sequential processes in protein synthesis  | <b>K1 &amp; K2</b>       |
| 3.  | Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.                | <b>K2 &amp; K4</b>       |
| 4.  | Able to distinguish lytic and lysogenic cycle and explain the mechanisms of genetic recombination of the microbes.                      | <b>K2 &amp; K5</b>       |
| 5.  | Understand the principle and application of rDNA technology for the welfare of human being.   | <b>K2 &amp; K3</b>       |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | Structure, properties and functions of genetic materials: DNA as the genetic Materials - Basic structure of DNA and RNA, alternate and unusual forms of DNA - Physical and Chemical properties of nucleic acid, base properties, denaturation and renaturation, T <sub>m</sub> and cot values, hybridization.  |
| <b>II</b>    | <b>Genetic code</b> - Methods of deciphering the genetic code and general features of the code word dictionary. <b>Chromosomal genetics:</b> Molecular structure of chromosomes - mini, artificial, double miniature chromosomes. Principles and applications of microdissection of chromosomes. Variation in chromosome number and structure - Chromosome nomenclature - Chromosomal syndromes – Pedigree analysis. |
| <b>III</b>   | <b>Microbial Genetics:</b> Genetics of Virus – Viral chromosome, Lytic cycle, Lysogenic cycle - Bacterial genetics -Bacterial genome – LAC & TRP Operon Model - Gene transfer mechanisms in bacteria and virus - conjugation, transduction, sex-duction, and transformation. 1983 Nobel Prize for the discovery of Mobile Genetic Element (Transposons).   |

|   |  |
|---|--|
| <b>IV</b>   | Recombinant DNA technology: Recombinant DNA technology - Overview - Tools for Recombinant DNA Technology. Comparison of DNA replication and cloning, Principle and applications of different types of cloning methods – Vectors - types - Cloning and expression vectors, Significance of T7 RNA polymerase - Techniques used in recombinant DNA technology - generation of DNA fragments - Restriction endonucleases, DNA modifying enzymes, Ligases.   |
| <b>V</b>  | Introduction of rDNA into host cell - calcium chloride mediated gene transfer - <i>Agrobacterium</i> mediated gene transfer, electroporation, microinjection, liposome fusion, particle gun bombardment - Selection and screening of transformed cells - Expression of cloned gene; Application of rDNA technology in human welfare - Environment, Medicine and Agriculture. Types of genome editing and RNAi technology - 2020 Nobel Prize in Chemistry for discovery of Genome editing- CRISPR/CAS9 Model. |
| <b>Reading list</b>   |  |
| <ol style="list-style-type: none"> <li>1. Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley &amp; Sons. INC. New York, pp-740.</li> <li>2. Brooker, R. J. 2014. Genetics: Analysis and Principles. 5th Edition, McGraw Hill Publisher, pp-880.</li> <li>3. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd Edition). Pearson/Benjamin Cummings, San Francisco, pp-850.</li> <li>4. <a href="https://onlinecourses.swayam2.ac.in/cec21_bt02/preview">https://onlinecourses.swayam2.ac.in/cec21_bt02/preview</a></li> <li>5. <a href="https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/the-genetic-code">https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/the-genetic-code</a></li> </ol>   |  |
| <b>Recommended texts</b>  |  |
| <ol style="list-style-type: none"> <li>1. Griffiths, A. J. F., H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart. 2012. An Introduction to Genetic Analysis. 11th Edition, W. H. Greeman. New York.</li> <li>2. Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics, John Wiley Publications, pp-784.</li> <li>3. Watson, J. D., T. A. Baker, S. P. Bell, Alexander Gann, Michael Levine, Richard Losick. 2003. Molecular Biology of the Gene, (5<sup>th</sup> Edition). Cold Spring Harbor Laboratory Press, pp-912.</li> <li>4. Klug, W. S. and M. R. Cummings, C. A. Spencer. 2005. Concepts of Genetics, Benjamin - Cummings Publishing Company.</li> <li>5. Harti, D. L. 2002. Essential Genetics, A Genomic Perspective, Jones &amp; Bartlet.</li> <li>6. Krebs, J. E., E.S. Goldstein, S.T. Kilpatrick. 2018. Lewin's Genes XII, Jones &amp; Bartlet Publisher, pp-613.</li> <li>7. Watson, J. D., T. A. Baker S. P. Bell, A. Cann, M. Levine and R. Losick, 2014. Molecular Biology of Gene 7th Edition, Pearson Education RH Ltd. India.</li> </ol> |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | M          | L          | L          | S          | S          | S          | L          | M          | S           |
| <b>CO2</b>                              | S          | M          | M          | M          | S          | M          | M          | M          | L          | S           |
| <b>CO3</b>                              | M          | S          | L          | L          | M          | S          | M          | L          | S          | L           |
| <b>CO4</b>                              | S          | M          | S          | M          | M          | S          | S          | S          | S          | S           |
| <b>CO5</b>                              | S          | S          | S          | M          | E          | S          | M          | S          | M          | M           |

\*S - Strong; M - Medium; L - Low



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### EVOLUTION

**Core Paper-VIII**

**Paper Code: 23UPZOO1C06**

**Total Contact Hours: 90**

**Credits: 4**

**Weekly Contact Hours: 5**

|  |   |                           |
|--|---|---------------------------|
| <b>Course Objectives:</b>  |   |                           |
| The main objectives of this course are:  |   |                           |
| 1.   | To critically analyze the concepts of evolution in order to   |                           |
| 2.   | Understand the factors responsible for origin and generation of diversity among living beings and   |                           |
| 3.   | To develop strategies for sustenance of life on this planet   |                           |
| 4.   | To critically analyze the concepts of evolution in order to   |                           |
| <b>Course</b>  | :   | <b>Core-VIII (Theory)</b> |
| <b>Course title</b>  | :   | <b>Evolution</b>          |
| <b>Credits</b>   | :   | <b>4</b>                  |
| <b>Pre-requisite:</b>  |   |                           |
| Students shall have basic knowledge on the diversity of animals, biology including morphological, anatomical, physiological and embryological features of various phyla and their environment. |   |                           |
| <b>Expected Course Outcome:</b>  |   |                           |
| On the successful completion of the course, student will be able to  |   |                           |
| 1.   | To understand the concept of evolution. It provides a comprehensive account of evidences to support concept of evolution and different theories for exploring the mechanism of evolution. | <b>K1 &amp; K3</b>        |
| 2.   | Study the origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.   | <b>K1 &amp; K2</b>        |
| 3.   | Understand the major events in the evolutionary time scale; Origins of unicellular and multi-cellular organisms.  | <b>K2 &amp; K3</b>        |
| 4.   | Comprehend the origin of new genes and proteins; Gene duplication and divergence.   | <b>K2 &amp; K4</b>        |
| 5.   | Appreciate the concepts and rate of change in gene frequency through natural selection, migration and random genetic drift  | <b>K4 &amp; K5</b>        |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | Emergence of evolutionary thoughts: Lamarck and Darwin – concepts of variation, adaptation, struggle, fitness and natural selection – Mendelism - Spontaneity of mutations - The evolutionary synthesis   |
| <b>II</b>    | Origin of cells and unicellular evolution: Origin of basic biological molecules - Abiotic synthesis of organic monomers and polymers - Concept of Oparin and Haldane - Experiment of Miller (1953) - The first cell - Evolution of prokaryotes - Origin of eukaryotic cells - Evolution of unicellular eukaryotes - Anaerobic metabolism, photosynthesis and aerobic metabolism |
| <b>III</b>   | Paleontology and evolutionary history: The evolutionary time scale - Eras, periods and epoch - Major events in the evolutionary time scale - Origins of unicellular and   |

|   |  |
|---|--|
|   | multi cellular organisms - Stages in primitive evolution including <i>Homo sapiens</i> . Noble Prize for Physiology or Medicine (2022) related to human evolution.   |
| <b>IV</b>   | Molecular evolution: Molecular divergence - Molecular tools in phylogeny, classification and identification - Protein and nucleotide sequence analysis - Origin of new genes and proteins - Gene duplication and divergence  |
| <b>V</b>  | The mechanisms: Population genetics - Populations, Gene pool, Gene frequency - Hardy-Weinberg Law - concepts and rate of change in gene frequency through natural selection, migration and random genetic drift- Adaptive radiation - Isolating mechanisms – Speciation - Allopatricity and Sympatricity - Convergent evolution - Sexual selection - Co-evolution - Altruism and evolution. Types and applications of Phylogenetic analysis using DNA, RNA, Proteins and Immunoglobulin molecules. |
| <b>Reading list</b>   |  |
| <ol style="list-style-type: none"> <li>1. Bergstrom, C. T. and L. A. Dugatkin. 2012. Evolution, Second MEDIA Edition. W.W. Norton &amp; Company, International Student Edition, pp-756.</li> <li>2. Jobling, M., E. Hollox, M. Hurlles, T. Kivisild and C. T. Tyler Smith. 2014. Human Evolutionary Genetics. Second Edition. Garland Sciences, London, pp-650.</li> <li>3. Veer Bala Rostogi, 2018. Organic Evolution (Evolutionary Biology), Thirteenth Edition Vinoth Kumar Jain, Scientific International (Pvt.) Ltd, New Delhi, pp-590.</li> <li>4. <a href="https://www.flipkart.com/books/evolution~contributor/pr?sid=bks">https://www.flipkart.com/books/evolution~contributor/pr?sid=bks</a></li> <li>5. <a href="http://www.evolution-textbook.org/">http://www.evolution-textbook.org/</a></li> <li>6. <a href="https://onlinelibrary.wiley.com/journal/15585646">https://onlinelibrary.wiley.com/journal/15585646</a></li> <li>7. <a href="http://darwin-online.org.uk/">http://darwin-online.org.uk/</a></li> </ol> |  |
| <b>Recommended texts</b>  |  |
| <ol style="list-style-type: none"> <li>1. Strickberger. M. W. 2000. Evolution. Third Edition, Jones Bartlett Publishers, pp-722.</li> <li>2. Hall B. K. and B. Hallgrimsson. 2014. Strickberger's Evolution. Fifth Edition, Bartlett Learning, An Ascend Learning Company, pp-642.</li> <li>3. Barton, N.H., D. Briggs, J.A. Eisen David, D.B. Goldstein and N.H. Patel. 2007. Evolution. Cold Spring Harbor Laboratory Press, pp-833.</li> </ol>   |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | M          | S          | M          | S          | M          | L          | S          | M          | L          | M           |
| <b>CO2</b>                              | S          | S          | L          | S          | S          | L          | S          | S          | S          | S           |
| <b>CO3</b>                              | S          | M          | S          | S          | S          | S          | S          | L          | L          | M           |
| <b>CO4</b>                              | S          | S          | S          | S          | S          | M          | S          | S          | S          | L           |
| <b>CO5</b>                              | S          | S          | S          | M          | M          | S          | S          | L          | L          | M           |

\*S - Strong; M - Medium; L – Low



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### ANIMAL PHYSIOLOGY

**Core Paper-IX**

**Paper Code: 23UPZOO1C07**

**Total Contact Hours: 90**

**Credits: 4**

**Weekly Contact Hours: 5**

| <b>Course Objectives:</b>  |  |                          |
|--|--|--------------------------|
| The main objectives of this course are:  |  |                          |
| 1.   | Students acquire the basic knowledge on physiology of different organs in animals and human.   |                          |
| 2.   | Understand the functions of different systems such as digestion, excretion, blood circulatory system, respiration and nervous system of animal relating them to structure and functions of various organs. |                          |
| <b>Course</b>  | :  | <b>Core-IX (Theory)</b>  |
| <b>Course title</b>  | :  | <b>Animal Physiology</b> |
| <b>Credits</b>   | :  | <b>4</b>                 |
| <b>Pre-requisite:</b>  |  |                          |
| Students should know the fundamentals of structure and functions of organs and organ systems of animals. |  |                          |
| <b>Expected Course Outcome:</b>  |  |                          |
| On the successful completion of the course, student will be able to                                      |  |                          |
| 1.   | Understand the functions of different systems of animals   | <b>K1</b>                |
| 2.   | Learn the comparative anatomy of heart structure and functions   | <b>K2</b>                |
| 3.   | Know the transport and exchange of gases, neural and chemical regulation of respiration  | <b>K2 &amp; K4</b>       |
| 4.   | Acquire knowledge on the organization and structure of central and peripheral nervous systems  | <b>K3 &amp; K5</b>       |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | <b>Blood and circulation:</b> Blood cells, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, Mechanism of blood clotting and its physiological and genetic relevance. Blood-borne diseases, haemoglobin, immunity, haemostasis. <b>Cardiovascular system</b> : Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG & ECHO – their principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above. Myocardial infarction, Atherosclerosis and Hypertrophy. Angioplasty and its significance. |
| <b>II</b>    | <b>Respiratory system:</b> Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. High altitude and low altitude physiological response, high-altitude cerebral edema (HACE) and high-altitude pulmonary edema (HAPE); <b>Muscle Physiology</b> -Types of muscles in Human. Mechanism of Muscle Contraction and relaxation.   |
| <b>III</b>   | <b>Nervous system:</b> Structure and types of Neurons, Nerve impulse conduction and transmission- action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Neuro degenerative diseases and narcolepsy. Sense organs: Molecular mechanism of Vision, hearing and tactile response  |

|           |  |
|-----------|--|
| <b>IV</b> | <b>Digestive system:</b> Anatomy of Gastro-intestinal system, Process of Digestion, absorption and assimilation of nutrients, Significance of energy balance and BMR. Method of calculation of BMR rate. Excretory system: Comparative physiology of excretion, Ultra structure and function of Kidney and its hormonal regulation, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance. Concept of kidney stone formation.  |
| <b>V</b>  | <b>Endocrine and Reproductive System:</b> Physiology of Endocrine glands, Types of hormones and basic mechanism of hormone action. Endocrine disorders: hormones and diseases; Histology of Testis and Ovary. Physiological significance of cells in testis and Ovary. Molecular and Cellular Mechanisms in Reproduction and Early Development, Mechanism of ovulation and its neuroendocrine regulation. Biological importance of super ovulation. Causative factors of antifertility and infertility Thermoregulation: Concept of Poikilotherms and Homeotherms. Comfort zone, body temperature- physical, chemical, neural regulation, acclimatization: Stress and adaptation |

#### Reading list

1. Prosser C. L. 1991, Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley-Liss Publishers, pp-592
2. Hoar, S.W. 1983, General and Comparative Physiology, Prentice Hall Publication, pp-928.
3. Randall, D., W. Burggren, K. French and R. Eckert. 2001, Animal Physiology Mechanisms and Adaptations, New York : W.H. Freeman and Co., pp-
4. Nelson K. S. 1997. Animal Physiology: Adaptation and Environment, Cambridge University Press, pp- 617.
5. Dantzler, W.H. 1997. Comparative Physiology (Handbook of Physiology), Volumes I and II. Edited by William H. Dantzler. pp - 1824 Published for the American Physiological Society by Oxford University Press Inc., New York. Oxford University Press Canada, Toronto.
6. [https://swayam.gov.in/nd1\\_noc20\\_bt42/preview](https://swayam.gov.in/nd1_noc20_bt42/preview)
7. <https://www.classcentral.com/course/swayam-animal-physiology-12894>
8. [https://swayam.gov.in/nd1\\_noc20\\_hs33/preview](https://swayam.gov.in/nd1_noc20_hs33/preview)

#### Recommended texts

1. Shepherd, G. M. 1994. Neurobiology, OUP USA Publsiher, pp-774.
2. Hainsworth , F.R. 1981. Animal Physilogy: Adaptation in function, Addison Wesley Longman Publishers, pp-669.
3. Mcfarland, D. 1999. Animal Behaviour: Psychobiology, Ethology and Evolution, Longman Publisher, pp-592.
4. Gorden, M.S. *et al.*, 1977. Animal Physiology: Principles and Adaptation, New York, Third Edition.
5. Ahearn, G.A. *et al.*, 1988. Advances in Comparative and Environmental Physiology – 2, Springer Publishers, pp-252.
6. Hill, R.W. 1976. Comparative Physiology of Animals: Environmental Approach, Longman Higher Education Publisher, pp-656.
7. Withers, P.C. 1992. Comparative Animal Physiology, Brooks/Cole Publisher, pp-900.

#### Mapping with Programme Outcomes\*

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | M   | S   | M   | S   | M   | L   | S   | M   | S   | S    |
| CO2 | S   | S   | M   | S   | S   | S   | S   | M   | S   | S    |
| CO3 | S   | M   | S   | S   | S   | M   | L   | S   | M   | S    |
| CO4 | S   | S   | S   | S   | S   | L   | M   | S   | S   | M    |
| CO5 | S   | S   | S   | M   | M   | M   | M   | L   | L   | M    |

\*S - Strong; M - Medium; L – Low



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**M.Sc. Zoology Course - SEMESTER-I**  
(This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**LAB COURSE IV**  
(GENETICS, EVOLUTION & ANIMAL PHYSIOLOGY)

Core Paper-X

Paper Code: 23UPZOO1L04

Total Contact Hours: 108

Credits: 3

Weekly Contact Hours: 6

|  |   |   |
|--|---|---|
| <b>Course Objectives:</b>  |   |   |
| The main objectives of this course are:  |   |   |
| 1.   | To learn on the transmission of heritable traits.                             |   |
| 2.   | To have hands on experience in handling of hormone related disorders.         |   |
| 3.   | To study the significance of vestigial organs in humans.                      |   |
| <b>Course</b>  | :   | <b>Core-X (Practical)</b>   |
| <b>Course title</b>  | :   | <b>Lab Course-IV: Genetics, Evolution &amp; Animal Physiology</b> |
| <b>Credits</b>   | :   | <b>3</b>  |
| <b>Pre-requisite:</b>  |   |   |
| To learn on the transmission of heritable traits. To have hands on experience in handling of hormone related disorders. To study the significance of vestigial organs in humans. |   |   |
| <b>Expected Course Outcome:</b>  |   |   |
| On the successful completion of the course, student will be able to:   |   |   |
| 1.   | Understand the transmission of different heritable traits.                    | <b>K2, K3 &amp; K4</b>  |
| 2.   | Students will identify endocrine and pheromone glands in mammals and insects. | <b>K2 &amp; K3</b>  |
| 3.   | Students will learn on vestigial organs and their role in evolution.          | <b>K2 &amp; K3</b>  |

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

**BIOCHEMISTRY**

1. Preparation of buffers and pKa value determination
2. Principles and Laws of Spectrophotometric Methods
3. Estimation of Blood sugar Post prandial for students and teachers (Glucometer)
4. Estimation of Glucose (Anthrone method)
5. Effect of temperature and pH on amylase activity of your saliva. Tabulate the data of your Class students and teachers. Compare Diabetic and non-diabetic individual's.
6. Isolation, estimation (Spectrophotometric- Lowry's Method)
7. Molecular Docking protein- ligand interaction (using free online software)

**8. Spotters :**

UV-Visible Spectrophotometer, Agarose gel electrophoretic apparatus, Poly acrylamide Gel Electrophoretic Apparatus, Glucometer, Thin layer Chromatographic apparatus, Laminar air flow chamber, Sterilization units, pH meter, Light and Fluorescent microscopes

**9. Biochemical Disorders**

Adrenoleukodystrophy.  
Diabetes, type 1.



Gaucher disease.  
 Hereditary hemochromatosis.  
 Lesch-Nyhan syndrome.  
 Maple syrup urine disease.  
 Menkes syndrome

### 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 Night Blindness)
5. Genetic Counseling methods (Among Student Volunteers)

### EVOLUTION

1. Identification of Vestigial organs in human by Student Volunteers
2. Study of fossils and living fossils from models/pictures
3. Problems related to changes in allelic frequencies using Hardy-Weinberg Law
4. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation
5. Study of Homology and Analogy from suitable specimens

### ANIMAL PHYSIOLOGY

1. Resting, Normal walk and fast running effects on heart beat ( using smart phone/smart watch)
2. Electro Cardio Gram (ECG) data collection for students and Analysis
3. Determination of Blood pressure for students and teachers using Digital Blood Pressure Monitor
4. Identification of thyroidism among the students and teachers (ELISA Test)
5. Effect of pH on opercular movement in fish
6. Effect of temperature on opercular movement in fish
7. Identification of Endocrine glands in mammals (Voucher Specimen)
8. Identification of Endocrine glands in insect (Voucher Specimen)
9. Pregnancy testing for hcG in urine samples

#### **Text Books:**

1. Nigam SC, Nigam SC and Omkar (2006) Experimental Animal Physiology and Biochemistry, New Age International.
2. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.
3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528

#### **Reference Books:**

1. Preeti, G., and C. Mridula, 2000. Modern Experimental Zoology, Indus International Publication.
2. Sinha, J., A. K. Chatterjee, P. Chattopadhyaya. 2011. Advanced Practical Zoology, Arunabha Sen Publishers, pp-1070.

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | <b>S</b>   | <b>S</b>   | <b>S</b>   | <b>M</b>   | <b>S</b>   | <b>S</b>   | <b>M</b>   | <b>S</b>   | <b>M</b>   | <b>S</b>    |
| <b>CO2</b>                              | <b>S</b>   | <b>M</b>   | <b>L</b>   | <b>S</b>   | <b>M</b>   | <b>S</b>   | <b>M</b>   | <b>M</b>   | <b>M</b>   | <b>M</b>    |
| <b>CO3</b>                              | <b>M</b>   | <b>M</b>   | <b>L</b>   | <b>S</b>   | <b>L</b>   | <b>S</b>   | <b>M</b>   | <b>L</b>   | <b>M</b>   | <b>M</b>    |
| <b>CO4</b>                              | <b>S</b>   | <b>S</b>   | <b>L</b>   | <b>S</b>   | <b>L</b>   | <b>S</b>   | <b>M</b>   | <b>L</b>   | <b>M</b>   | <b>L</b>    |
| <b>CO5</b>                              | <b>S</b>   | <b>S</b>   | <b>M</b>   | <b>L</b>   | <b>M</b>   | <b>S</b>   | <b>M</b>   | <b>S</b>   | <b>M</b>   | <b>M</b>    |

\*S - Strong; M - Medium; L – Low



**PERIYAR UNIVERSITY**  
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**M.Sc. Zoology Course - SEMESTER-III**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**MEDICAL LABORATORY TECHNIQUES**

**Core Paper-XI (Industry Module)**

**Paper Code: 23UPZOO1C08**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|  |   |                                      |
|--|---|--------------------------------------|
| <b>Course Objectives:</b>  |   |                                      |
| The main objectives of this course are:  |   |                                      |
| 1.   | Students should understand the different protocols and procedures to collect clinical samples.  |                                      |
| <b>Course</b>  | :   | <b>Core-XI (Industry Module)</b>     |
| <b>Course title</b>  | :   | <b>Medical Laboratory Techniques</b> |
| <b>Credits</b>   | :   | <b>2</b>                             |
| <b>Pre-requisite:</b>  |   |                                      |
| Students should have a basic knowledge about medical laboratories and the works carried out by them.   |   |                                      |
| <b>Expected Course Outcome:</b>  |   |                                      |
| Upon completion of this course, Students would have  |   |                                      |
| I  | Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.   | <b>K2 &amp; K3</b>                   |
| II   | Explain the characteristics of clinical samples and demonstrate skill in handling clinical equipment.   | <b>K3, K4 &amp; K5</b>               |
| III  | Evaluate the hematological and histological parameters of biological samples.   | <b>K3, K4, K5 &amp; K6</b>           |
| <b>K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create</b>  |   |                                      |
| <b>Units</b>   |   |                                      |
| I  | Laboratory safety - toxic chemicals and biohazards waste- biosafety level- good laboratory practice - hygiene and health issue - physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.  |                                      |
| II   | Composition of blood and their function- collection of blood & lab procedure-haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count WBC- blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count. |                                      |
| III  | Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome-Computer tomography (CT scan) - Magnetic Resonance imaging - flowcytometry - treadmill test - PET.  |                                      |
| IV   | Cardiovascular system- Blood pressure - Pulse - regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) - significance - ultra sonography- Electroencephalography (EEG).   |                                      |
| V  | Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining - staining methods - vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.   |                                      |
| <b>Reading list</b>  |   |                                      |
| 1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai.<br>2. Guyton and Hall, 2000. Text Book of medical Physiology, 10 <sup>th</sup> edition, Elseiner, New Delhi.<br>3. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol,I,II,III. Tata MC GrawHill, New Delhi.<br>4. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation. |   |                                      |

**Recommended texts**

1. Manoharan,A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeyppee brothers, New Delhi.
2. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia. Published by Tata McGraw-Hill Education Pvt. Ltd.,
3. Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

**Mapping with Programme Outcomes\***

| <b>COs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b> | S          | M          | M          | M          | L          | L          | M          | M          | L          | M           |
| <b>CO2</b> | S          | S          | M          | S          | S          | S          | L          | M          | S          | S           |
| <b>CO3</b> | M          | S          | S          | S          | S          | S          | S          | S          | S          | L           |
| <b>CO4</b> | S          | S          | M          | M          | L          | M          | L          | M          | M          | S           |
| <b>CO5</b> | M          | M          | S          | S          | M          | S          | L          | L          | S          | S           |

\*S - Strong; M - Medium; L-Low



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**M.Sc. Zoology Course - SEMESTER-III**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

### STEM CELL BIOLOGY

**Elective Paper-V**

**Paper Code: 23UPZOO1E09**

**Total Contact Hours: 54**

**Credits: 3**

**Weekly Contact Hours: 3**

|  |   |                          |
|--|---|--------------------------|
| <b>Course Objectives:</b>  |   |                          |
| The main objectives of this course are:                                  |   |                          |
| 1.   | Students should understand the basics of stem cells                     |                          |
| <b>Course</b>  | :   | <b>Elective-V</b>        |
| <b>Course title</b>  | :   | <b>Stem Cell Biology</b> |
| <b>Credits</b>   | :   | <b>3</b>                 |
| <b>Pre-requisite:</b>  |   |                          |
| Students should understand the basics of stem cells and its applications |   |                          |
| <b>Expected Course Outcome:</b>  |   |                          |
| On the successful completion of the course, student will be able to      |   |                          |
| I  | Understand the basic knowledge of stem cells and their origin           | <b>K1 &amp; K2</b>       |
| II   | Differentiating the embryonic and adult stem cells                      | <b>K3 &amp; K4</b>       |
| III  | Understand and apply the current stem cell therapies for their research | <b>K5</b>                |

**K1-** Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

| <b>Units</b>        |   |
|---------------------|---|
| <b>I</b>            | Introduction to stem cell biology: 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 cells, adult stem cells and induced pluripotent stem cells).   |
| <b>II</b>           | Embryonic stem (ES) cell: Characterization and properties of ES cells , pluripotency and self-renewal of ES cells; molecular mechanisms regulating pluripotency and maintenance of the stem state, progressive differentiation of ES cells into ectoderm lineage organs (skin, brain and nerve), mesoderm lineage organs (heart, kidney, muscle, bone and blood), and endoderm lineage organs (lung, liver, stomach, pancreas and intestine). |
| <b>III</b>          | Adult stem cells: Mesenchymal stem cells (MSCs) - sources, properties (plasticity, homing and engraftment), potency and characterization; Haematopoietic stem cells (HSCs) - sources, properties, potency and characterization; steps involved in production of induced pluripotent stem cells (iPSCs); role of Yamanaka factor in iPSCs.   |
| <b>IV</b>           | Stem cell and aging: aging theory; cell cycle; telomere and telomerase; senescence of stem cell; role of stem cell in aging; tissue repair and regeneration of adult stem cell.   |
| <b>V</b>            | Current stem cell therapies: Advantages and disadvantages of ES cells and adult stem cells (MSCs and HSCs) therapy; Ethical concern on stem cell therapy; current stem cell therapy for various diseases; clinical outcome of stem cell therapy; state of clinical trials in adult stem cells for various diseases.   |
| <b>Reading list</b> |   |

1. Kiessling, A.A. 2006. Human Embryonic Stem Cells (Second Ed.), Jones & Barlett Publishers.
2. Lanza, R. and A. Atala. 2005. Essentials of Stem Cell Biology. Academic Press, pp-712.
3. Turksen, K. 2004. Adult Stem Cells. Humana Press, Inc, pp-429.
4. Lanza, R. *et al.* 2004. Handbook of Stem Cells: Embryonic/Adult and Fetal Stem Cells (Vol. 1 & 2). Academic Press, pp-1626.
5. Institute of Medicine, 2002. Stem cells and the future of regenerative medicine. National Academy Press, pp-112.
6. Marshak, D., R.L. Gardner and D. Gottlieb. 2001. Stem Cell Biology, Cold Spring Harbour Monograph Series, 40, pp-550.
7. Booth, C. 2003. Stem Cell Biology and Gene Therapy, Cell Biology International, Academic Press.

**Recommended texts**

1. Quesenberry, P.J., G.S. Stein, B. Forget and S. Weissman. 2001. Stem Cell Biology and Gene Therapy, Wiley Publishers, pp-584.
2. Sell, S. and Totowa, N.J. 2004. Stem Cells Handbook, Humana Press, pp-534.
3. Sullivan, S., C. A. Cowan and K. Eggan. 2007. Human Embryonic Stem Cells: The Practical Handbook, Wiley Publishers, pp-424.
4. Battler, A., and Leo, J. 2007. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Springer Publication, pp-422.

**Mapping with Programme Outcomes\***

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | M   | S   | M   | S   | M   | S   | M   | S   | M   | M    |
| CO2 | S   | S   | M   | S   | S   | S   | S   | S   | S   | L    |
| CO3 | S   | M   | S   | S   | S   | S   | M   | L   | S   | M    |
| CO4 | S   | S   | S   | S   | S   | M   | M   | S   | L   | M    |
| CO5 | S   | S   | S   | M   | M   | S   | S   | S   | S   | S    |

\*S - Strong; M - Medium; L-Low



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**M.Sc. Zoology Course - SEMESTER-III**  
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### REGENERATIVE MEDICINE

**Elective Paper-V**

**Paper Code: 23UPZOO1E10**

**Total Contact Hours: 54**

**Credits: 3**

**Weekly Contact Hours: 3**

|   |  |                              |
|---|--|------------------------------|
| <b>Course Objectives:</b>   |  |                              |
| The main objectives of this course are:                             |  |                              |
| 1.  | To account for regenerative medicine applications to human diseases  |                              |
| <b>Course</b>   | :  | <b>Elective V</b>            |
| <b>Course title</b>   | :  | <b>Regenerative Medicine</b> |
| <b>Credits</b>  | :  | <b>3</b>                     |
| <b>Pre-requisite:</b>   |  |                              |
| To account for regenerative medicine applications to human diseases |  |                              |
| <b>Expected Course Outcome:</b>                                     |  |                              |
| On the successful completion of the course, student will be able to |  |                              |
| I   | To identify and isolate basic scientific, translational, clinical, (and where relevant) epidemiological, demographic and social elements of their research problem | <b>K1 &amp; K2</b>           |
| II  | Students will gain in depth practical knowledge of the biology of stem cells and their differentiation potentials.   | <b>K3 &amp; K4</b>           |
| III   | To describe methods of applications to replace damaged or destroyed cells including tissue engineering   | <b>K5</b>                    |
| IV  | To account for regenerative medicine applications to human diseases  | <b>K3 &amp; K4</b>           |
| V   | To account for and evaluate current theories, methods and techniques within the research field, their practical execution and application                          | <b>K4 &amp; K5</b>           |

**K1-** Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | Stem cell evolution, Historical perspective - with model systems, Stemness basic, Type of stem cells, Stem cell markers, Stem cell niches, Trans-differentiation, properties and characterization stem cells, Stem Cell Therapy. |
| <b>II</b>    | Isolation of Pluripotent stem cell and molecular mechanism of Self renewal and differentiation Current status of induced pluripotent stem cells (iPSCs); iPSCs clinical applications).   |
| <b>III</b>   | Hematopoietic and non-hematopoietic stem cells and their differentiation MSCs Stem cell bioengineering.  |
| <b>IV</b>    | Applications of Regenerative Medicine in the nervous system, eye, heart, lung, liver, kidney, pancreas and kidney; large-scale manufacturing of cells, tissues and organs; artificial organs.                                    |
| <b>V</b>     | Gene therapy applications; Engineered Tissues and Regenerative Medicine; Molecular therapy for regeneration; Personalized therapies in Regenerative Medicine.  |

|  |
|--|
|  |
| <b>Reading list</b>  |
| <ol style="list-style-type: none"> <li>1. AnthonyAtala, James A. Thomson. Principles of Regenerative Medicine. Academic Press; 1 edition (December 4, 2007).</li> <li>2. Atala A. Foundations of Regenerative Medicine: Clinical and Therapeutic Applications. Academic Press; 1 edition (August 28, 2009).</li> <li>3. Hossein Baharvand (Editor), Nasser Aghdami (Editor). Regenerative Medicine and Cell Therapy (Stem Cell Biology and Regenerative Medicine). Humana Press; 2013 edition (August 8, 2012).</li> </ol>   |
| <b>Recommended texts</b>   |
| <ol style="list-style-type: none"> <li>1. Gustav Steinhoff (Editor). Regenerative Medicine.Springer; 1st Edition.edition (March 3, 2011).</li> <li>2. David L. Stocum. Regenerative Biology and Medicine, Second Edition.Academic Press; 2<sup>nd</sup> edition (June 14, 2012).</li> <li>3. Human Pluripotent Stem Cells: Methods and Protocols (Methods in Molecular Biology) 2011th Edition by Philip H. Schwartz (Editor), Robin L. Wesselschmidt.</li> <li>4. Atlas of Human Pluripotent Stem Cells: Derivation and Culturing (Stem Cell Biology and Regenerative Medicine) 2011 by Michal Amit and Joseph Itskovitz-Eldor.</li> <li>5. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Alexander Battler, Jonathan Leo, Springer.</li> </ol> |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | M          | S          | M          | S          | M          | S          | M          | S          | M          | M           |
| <b>CO2</b>                              | S          | S          | M          | S          | S          | S          | S          | S          | S          | L           |
| <b>CO3</b>                              | S          | M          | S          | S          | S          | S          | M          | L          | S          | M           |
| <b>CO4</b>                              | S          | S          | S          | S          | S          | M          | M          | S          | L          | M           |
| <b>CO5</b>                              | S          | S          | S          | M          | M          | S          | S          | S          | S          | S           |

\*S - Strong; M - Medium; L-Low



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**PERIYAR UNIVERSITY**  
**DEPARTMENT OF ZOOLOGY**  
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**M.Sc. Zoology Course - SEMESTER-III**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**DAIRY FARMING**

**Skill Enhancement Course (SEC) - II**

**Paper Code: 23UPZOO1S02**

**Total Contact Hours: 36**

**Credits: 1**

**Weekly Contact Hours: 2**

|  |   |  |
|--|---|--|
| <b>Course Objectives:</b>  |   |  |
| The main objectives of this course are:  |   |  |
| <b>1.</b>  | Students should know basic concepts in Vermiculture   |  |
| <b>Course</b>  | :   | <b>Skill Enhancement Course (SEC) - II</b> |
| <b>Course title</b>  | :   | <b>Dairy Farming</b>                       |
| <b>Credits</b>   | :   | <b>2</b>                                   |
| <b>Pre-requisite:</b>  |   |  |
| Students should be aware of economic and cultural importance of Dairy farming. |   |  |
| <b>Expected Course Outcome:</b>  |   |  |
| Upon completion of this course, Students would have                            |   |  |
| I  | To understand the various practices in Dairy farming. To know the needs for Dairy farming and the status of India in global market. | <b>K2 &amp; K3</b>                         |
| II   | To be able to apply the techniques and practices needed for Dairy farming.  | <b>K1, K2 &amp; K3</b>                     |
| III  | To know the difficulties in Dairy farming and be able to propose plans against it.  | <b>K5 &amp; K6</b>                         |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b>   |  |
|--|--|
| <b>I</b>   | Introduction to Dairy Farming- Advantages of dairying- Classification of breeds of cattle-Indigenous and exotic breeds- Selection of dairy cattle. Breeding-artificial insemination-Dairy cattle management-General Anatomy.   |
| <b>II</b>  | Construction of Model Dairy House - Types of Housing - Different Managemental Parameters - Winter Management - Summer Management   |
| <b>III</b>   | Feedstuffs available for livestock- Roughages -Concentrates - Energy rich concentrates - Protein rich concentrates - Mineral Supplements - Vitamin Supplements - Feed additives - Feeding management - Calves Feeding - Feeding of adults - Feeding of pregnant dairy animals - Feeding pregnant heifer. |
| <b>IV</b>  | Milk-Composition of milk-milk spoilage-pasteurization - Role of milk and milk products in human nutrition – Dairying as a source of additional income and employment.  |
| <b>V</b>   | Contagious disease - Common Bacterial - Protozoal - Helminth and Viral Diseases - Parasitic Infestation - Vaccination - Biosecurity.   |
| <b>Reading list</b>  |  |
| 1.The Veterinary Books for Dairy Farmers by Roger W. Blowey.<br>2. Hand Book of Dairy Farming by Board Eiri.<br>3. Handbook of animal husbandry TATA, S.N ed., ICAR 1990<br>4. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai.<br>5. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea & Fabiger Publisher. |  |
| <b>Recommended texts</b>   |  |



1. [https://agritech.tnau.ac.in/farm\\_enterprises/Farm%20enterprises\\_%20Dairy%20unit.html](https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Dairy%20unit.html)
2. <https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Tata,+S.N.,+ed%22>
3. 15. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.
4. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, NewYork.

**Mapping with Programme Outcomes\***

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | M   | S   | L   | L   | S   | S   | M   | S   | L   | M    |
| CO2 | M   | S   | S   | S   | M   | S   | M   | L   | S   | S    |
| CO3 | M   | S   | S   | S   | S   | S   | S   | S   | S   | M    |
| CO4 | M   | S   | S   | S   | M   | M   | L   | L   | M   | M    |
| CO5 | S   | S   | S   | M   | S   | M   | S   | L   | S   | S    |

\*S - Strong; M - Medium; L – Low



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**M.Sc. Zoology Course - SEMESTER-III**  
(This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**INTERNSHIP/ FIELD SURVEY/ INDUSTRIAL ACTIVITY**

Internship/ Field Survey/ Industrial Activity

Paper Code: 23UPZOO1101

**Credits: 2**

|  |  |  |
|--|--|--|
| <b>Course Objectives:</b>  |  |  |
| The main objectives of this course are:  |  |  |
| 1.   | To gain industrial exposure in life science field.   |  |
| 2.   | To know the opportunities in research and development activities by visiting industries.                 |  |
| <b>Course</b>  | :  | <b>Internship / Field Survey / Industrial Activity</b> |
| <b>Course title</b>  | :  | <b>Internship / Field Survey / Industrial Activity</b> |
| <b>Credits</b>   | :  | <b>2</b>   |
| <b>Pre-requisite:</b>  |  |  |
| To gain professional learning experience and develop new skills in life science field. |  |  |
| <b>Expected Course Outcome:</b>  |  |  |
| Upon completion of this lab course, the students                                       |  |  |
| 1.   | At the completion of this course, students will be able to gain new skills required for industrial jobs. | K3, K4, K5, K6   |

**K1-** Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create



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**M.Sc. Zoology Course - SEMESTER-II**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

### CANCER THERAPEUTICS

**Non-Major Elective (NME) - II**

**Paper Code: 23UPZOO1N02**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|   |   |                                      |
|---|---|--------------------------------------|
| <b>Course Objectives:</b>   |   |                                      |
| The main objectives of this course are:                           |   |                                      |
| 1.  | Students should know the basic concepts in Cancer and Therapeutic measures.   |                                      |
| <b>Course</b>   | :   | <b>Non-Major Elective (NME) - II</b> |
| <b>Course title</b>   | :   | <b>Cancer Therapeutics</b>           |
| <b>Credits</b>  | :   | <b>2</b>                             |
| <b>Pre-requisite:</b>   |   |                                      |
| Students should be aware of molecular concepts in cancer biology. |   |                                      |
| <b>Expected Course Outcome:</b>                                   |   |                                      |
| Upon completion of this course, Students would have               |   |                                      |
| I   | Students will gain knowledge of tumorigenesis, learn techniques commonly used in cancer biology   | <b>K2 &amp; K3</b>                   |
| II  | The fundamental principles behind cancer prevention, and therapeutic management.  | <b>K1, K2 &amp; K3</b>               |
| III   | 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. | <b>K5 &amp; K6</b>                   |

**K1-** Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | <b>Surgery-</b> Developing and evaluation a cancer screening programme; Surgery and its types; Principles of Cancer management surgical oncology; Diagnose, score and treat side-effects and complications of surgical treatment.  |
| <b>II</b>    | <b>Chemotherapy-</b> Chemical carcinogenesis; Clinical examination; Applications of new technologies in prevention, assessing risk, diagnostics, and treatment. Concepts of combined modality treatment and the significance of radiation and chemotherapy in comprehensive management of cancer. 2019 Nobel Prize winners William G. Kaelin Jr., Sir Peter J. Ratcliffe, and Gregg L. Semenza, for their discoveries of how cells sense and adapt to oxygen availability was the top story in oncology. |
| <b>III</b>   | <b>Radiation therapy-</b> Radiological Examination; Primary radiological image formation, use of contrast media, Historical developments in Radiotherapy, Various types of sources used in Radiotherapy and their properties; Importance of Immobilization in radiotherapy, Physical and biologic basis of Radiation Oncology; Principles of Hyperthermia, Photodynamic Therapy for cancer Rationale, radiobiological factors, current clinical outcomes.  |
| <b>IV</b>    | <b>Cancer immunotherapy-</b> Exploitation of acquired immune response; Monoclonal antibody therapy; Antibody drug conjugation, T-cell engager, Pi-specific antibodies, CART (Chimeric Antigenic Receptor T-cells) and oncolytic viruses. Harnessing innate immunity; lymphokinatic activated killer cells, Interferon, Cytokines: biology and applications in cancer medicine; Active  |

|   |   |
|---|---|
|   | specific immunotherapy with vaccines; immunology for cancer prevention. 2018 Nobel Prize to James P. Allison and Tasuku Honjo for their discovery of cancer therapy by inhibition of negative immune regulation.  |
| <b>V</b>  | <b>Nanotherapeutics-</b> Principles of drug delivery systems, Nanodrugs for diagnosis and treatment of cancer; concept of nano drug encapsulation, self-assembly, controlled release (targeted, triggered release and Cellular uptake mechanisms), <i>in vitro</i> methods to study anticancer properties of nanomaterials, Nanoparticles for Photodynamic Therapy of cancer; Antisense and siRNA therapy; nanoparticle assisted vaccine development; nano shells for surgery. Nano-toxicology. |
| <b>Reading list</b>   |   |
| <ol style="list-style-type: none"> <li>1. Turksen K (2002) Embryonic Stem Cells Method and Protocols. Humana press.</li> <li>2. Korobkin R and Munzer SR (2007) Stem Cell Century, Law and Policy for a Breakthrough Technology, Yale University Press.</li> <li>3. Lanza R (2004) Hand Book of Stem Cells Volume 1and2, Elsevier press.</li> <li>4. Committee R (2004) Stem Cells and the Future of Regenerative Medicine by on the Biological and Biomedical Application of Stem Cell Research.</li> <li>5. Robertis EDP and De Robertis EMF (2005) Cell and Molecular Biology, (8th edn), De, B.I.Waverly Pvt. Ltd., New Delhi.</li> <li>6. Lodish H, Kaiser CA, Brasher A, Amon A, Berk A, Kreger M, Ploegh H and Scott MP (2012) Molecular Cell Biology, 7<sup>th</sup> edition, Garland Publishing, Inc. New York.</li> </ol> |   |
| <b>Recommended texts</b>  |   |
| <ol style="list-style-type: none"> <li>1. Kiessling, A.A. 2006. Human Embryonic Stem Cells (Second Ed.) Jones &amp; Barlett Publishers.</li> <li>2. Lanza, R. 2005. Essentials of Stem Cell Biology. Academic Press.</li> </ol>   |   |

| Mapping with Programme Outcomes* |     |     |     |     |     |     |     |     |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| COs                              | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1                              | S   | L   | L   | L   | L   | L   | S   | S   | L   | L    |
| CO2                              | S   | L   | M   | M   | S   | M   | M   | M   | S   | S    |
| CO3                              | S   | M   | M   | M   | S   | S   | S   | S   | M   | M    |
| CO4                              | S   | S   | S   | L   | S   | S   | S   | S   | S   | S    |
| CO5                              | S   | S   | M   | S   | S   | S   | M   | L   | S   | M    |

\*S - Strong; M - Medium; L – Low



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**M.Sc. Zoology Course - SEMESTER-IV**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**IMMUNOLOGY**

**Core Paper-XII**

**Paper Code: 23UPZOO1C09**

**Total Contact Hours: 126**

**Credits: 5**

**Weekly Contact Hours: 7**

|   |  |                          |
|---|--|--------------------------|
| <b>Course Objectives:</b>   |  |                          |
| The main objectives of this course are:   |  |                          |
| 1.  | To impart conceptual understanding of functional organization of immune system and its responsiveness in health and disease.               |                          |
| 2.  | To enable a successful performance in Immunology component of CSIR-UGC NET.  |                          |
| <b>Course</b>   | :  | <b>Core-XII (Theory)</b> |
| <b>Course title</b>   | :  | <b>Immunology</b>        |
| <b>Credits</b>  | :  | <b>5</b>                 |
| <b>Pre-requisite:</b>   |  |                          |
| Students would have basic knowledge in animal science, particularly functional anatomy, cell biology and developmental biology. |  |                          |
| <b>Expected Course Outcome:</b>   |  |                          |
| Students would have acquired clear knowledge on   |  |                          |
| 1.  | Various basic concepts in immunology and organization of immune systems.   | K2                       |
| 2.  | Mechanisms of immune response in health and their defects in various diseases.   | K2 & K4                  |
| 3.  | The application of immunological principles in biomedical sciences including blood transfusion, tissue grafting and organ transplantation. | K3 & K5                  |
| 4.  | Vaccinology and its importance in disease management   | K3                       |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |  |
|--------------|--|
| <b>I</b>     | Introduction to Immunology: An overview; Scope of immunology, recognition of self and non-self as a basic functional feature of immune system; Concepts of external and internal defense systems; External (first line / innate) defense system: components, distribution, salient functions; Internal (second line / acquired) immune system: cellular and humoral immune components- distribution, salient functions- primary and secondary immune responses; Immune tissues / organs: types, anatomical location, structure and development; lymphocyte traffic during development; Types of immunity: innate and acquired - types, functional features; concept of adaptive immunity |
| <b>II</b>    | Antigens: Definition, characteristic features and classification; Avidity and affinity, Epitope & Paratope - Antigenicity versus immunogenicity; Antigen-antibody interactions. Adjuvants: definition, types and applications  |
| <b>III</b>   | Major effector components of cellular immune system: Lymphocytes - types, morphology, clones; sub-populations, distribution, B and T cell receptors, B and T cell epitopes, Toll-like receptors; Antigen presenting cells: antigen processing and presentation, MHC molecules and their immunologic significance   |
| <b>IV</b>    | Major effector components of humoral immune system: Antibodies - Primary structure, classification, variants and antigen-antibody interactions; Structural and   |

|   |  |
|---|--|
|   | functional characteristics of various antibody classes; Generation of diversity; Monoclonal antibodies: definition, production and applications; Antibody engineering and its applications. Nanobodies. Complement system - Components, three major activation pathways, and immune functions including anaphylaxis and inflammation. Cytokines - Definition and salient functional features; Interleukins: definition, types (lymphokines and monokines), and functions. Interferons - Origin, types and functions  |
| V   | Diseases and immune responses: Hypersensitivity: definition, Types I to IV and immune manifestations; Auto-immune diseases: onset, spectrum of diseases, and major immune responses; Immunodeficiency diseases: types including SCID and consequences; Viral (HIV), bacterial (tuberculosis) and parasitic (malaria) diseases: etiology, host immune responses and evasion by pathogens; Plasma Therapy. COVID-19 infection, quarantine, control measures and Nobel Prize for COVID Vaccine; Vaccines: types, preparations, efficacies and recent developments. Cancer Vaccines. |
| <b>Reading list</b>   |  |
| <ol style="list-style-type: none"> <li>1. Kuby, J. 1997. Immunology. W. H. Freeman &amp; Co., New York, pp-670.</li> <li>2. Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7<sup>th</sup> edition), Mosby / Elsevier, Philadelphia, pp-472</li> <li>3. Abbas, A. K and A. H. Lichtman. 2007. Cellular and Molecular Immunology (6<sup>th</sup> edition), W. B. Saunders, Philadelphia, pp-564</li> <li>4. Coica, R. Sunshine, G. 2015. Immunology (Seventh Edition), Wiley Blackwell, UK, pp-406.</li> </ol>  |  |
| <b>Recommended texts</b>  |  |
| <ol style="list-style-type: none"> <li>1. Weir, D. M and J. Stewart. 1997. Immunology, Churchill Livingstone, London, pp-362</li> <li>2. Janeway, C. A and P. Travers. 1997. Immunology, Garland Publ. Inc., London, pp-904</li> <li>3. Peakman, M and D. Vergani. 1997. Basic and Clinical Immunology, Churchill Livingstone, London, pp-366</li> <li>4. Parham, P. 2009. The Immune System (Third Edition), Garland Science, USA, pp-506</li> <li>5. Weissman, I. Hood, L. Wood, W. 1978. Essential Concepts in Immunology, the Benjamin/Cummings, California, pp-165.</li> <li>6. Hood, L. Weissman, I. Wood, W. Wilson, J. 1984. Immunology (Second Edition), the Benjamin/Cummings, California, pp-558.</li> <li>7. Coica, R and Sunshine, G. 2009. Immunology A Short Course (Sixth Edition), John Wiley &amp; Sons, USA, pp-391.</li> <li>8. Doan, T. Melvold, R. Viselli, S. <i>et al.</i>, 2013. Immunology (Second Edition), Lippincott Williams &amp; Wilkins, Maryland, pp-376.</li> <li>9. Owen, J. A. Punt, J. Stanford, S. A. 2013. Kuby Immunology (7<sup>th</sup> Edition), Macmillan, England, pp-692.</li> </ol> |  |

| Mapping with Programme Outcomes* |     |     |     |     |     |     |     |     |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| COs                              | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
| CO1                              | S   | M   | S   | S   | S   | S   | M   | S   | S   | S    |
| CO2                              | S   | S   | M   | S   | S   | S   | M   | M   | S   | S    |
| CO3                              | S   | M   | M   | S   | S   | S   | S   | S   | S   | M    |
| CO4                              | M   | S   | M   | M   | S   | S   | S   | S   | S   | M    |
| CO5                              | M   | S   | S   | S   | M   | S   | M   | S   | S   | M    |

\*S - Strong; M - Medium; L – Low



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**M.Sc. Zoology Course - SEMESTER-IV**  
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**ECOLOGY**

**Core Paper-XIII**

**Paper Code: 23UPZOO1C10**

**Total Contact Hours: 126**

**Credits: 5**

**Weekly Contact Hours: 7**

|  |   |                           |
|--|---|---------------------------|
| <b>Course Objectives:</b>  |   |                           |
| The main objectives of this course are:  |   |                           |
| 1.   | Knowing the ecology and climatic changes at world level and its impact on natural resources.  |                           |
| 2.   | Understanding the contributing factors for pollution in the environment and the ways in controlling and restoring to natural conditions |                           |
| <b>Course</b>  | :   | <b>Core-XIII (Theory)</b> |
| <b>Course title</b>  | :   | <b>Ecology</b>            |
| <b>Credits</b>   | :   | <b>5</b>                  |
| <b>Pre-requisite:</b>  |   |                           |
| Students should know about the fundamentals and studied the ecology of living organisms. |   |                           |
| <b>Expected Course Outcome:</b>  |   |                           |
| On the successful completion of the course, student will be able to                      |   |                           |
| 1.   | Learn about the ecosystem, biotic communities and utilizing the energy processing   | <b>K2</b>                 |
| 2.   | Study the various community and population and population control   | <b>K2 &amp; K3</b>        |
| 3.   | Understand the fundamentals of climatic conditions and its impact on environment  | <b>K2 &amp; K6</b>        |
| 4.   | Realizing the nature of pollution and the ways for its control/reduction  | <b>K4 &amp; K5</b>        |
| 5.   | Impact of environmental studies on solid waste management   | <b>K2 &amp; K6</b>        |

**K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create**

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Ecological complexity and stability in food webs, Food chain and their significance, Ecological pyramids.  |
| <b>II</b>    | Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies ( <i>r</i> and <i>K</i> selection); Survivorship curves; concept of metapopulation-demes and dispersal, interdemec extinctions, age structured populations -action taken to control population explosion.   |
| <b>III</b>   | Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community ecology: 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 pioneer, intermediate (seral) and climax community. |
| <b>IV</b>    | 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, estuarine).   |

|  |  |
|--|--|
|  | Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.   |
| <b>V</b>   | Applied ecology: Environmental pollution; global environmental change; Microplastics pollution and remediation; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches - Waste management. Conservation biology: Principles of conservation, major approaches to management, Biodiversity hotspots – endemic, endangered and keystone species. Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves). |
| <b>Reading list</b>  |  |
| <ol style="list-style-type: none"> <li>1. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publication, India, pp-616.</li> <li>2. Calabrese, E.J. 1978. Pollutants and High-Risk Groups, John Wiley, pp-286.</li> <li>3. Raven, P.H. and L.R. Berg, G.B. Johnson, 1993. Environment, Saunders College Publishing, pp-579.</li> <li>4. Cunningham, W. P. and B. W. Saigo, 1999. Environmental Science, McGraw Hill Boston, 5th Edition.</li> <li>5. Online courses.nptel.ac.in / noc 19 - g e 23/preview</li> <li>6. Class central.com/course/swayam -ecology - and environment – 14021.</li> </ol> |  |
| <b>Recommended texts</b>   |  |
| <ol style="list-style-type: none"> <li>1. Odum, E.P. 1893. Basic Ecology, Saunders &amp; Co., Philadelphia, pp-383.</li> <li>2. Barthwl, R.R. 2002. Environmental Impact Assessment, New Age International Publishers, New Delhi, India, pp-425.</li> <li>3. United Nations Environment Programme (UNEP). 1995. Global Biodiversity Assessment, Cambridge University Press, pp-1140.</li> </ol>  |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | M          | S          | M          | S          | S          | M          | S           |
| <b>CO2</b>                              | S          | S          | M          | M          | L          | S          | S          | S          | M          | M           |
| <b>CO3</b>                              | S          | M          | M          | L          | M          | S          | L          | L          | S          | L           |
| <b>CO4</b>                              | M          | M          | S          | S          | M          | L          | L          | S          | S          | S           |
| <b>CO5</b>                              | M          | S          | S          | M          | S          | M          | L          | M          | L          | S           |

\*S - Strong; M - Medium; L – Low





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**M.Sc. Zoology Course - SEMESTER-IV**  
(This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**PROJECT WITH VIVA VOCE**

**Core Paper-XIV**

**Paper Code: 23UPZOO1P01**

**Total Contact Hours: 180**

**Credits: 7**

**Weekly Contact Hours: 10**

|   |  |                                      |
|---|--|--------------------------------------|
| <b>Course Objectives:</b>   |  |                                      |
| The main objectives of this course are:                                     |  |                                      |
| 1.  | To gain research knowledge.  |                                      |
| 2.  | To know how to execute independent research.   |                                      |
| <b>Course</b>   | <b>:</b>   | <b>Core-XIV (Project)</b>            |
| <b>Course title</b>   | <b>:</b>   | <b>Project with <i>viva voce</i></b> |
| <b>Credits</b>  | <b>:</b>   | <b>7</b>                             |
| <b>Pre-requisite:</b>   |  |                                      |
| To gain research knowledge and to know how to execute independent research. |  |                                      |
| <b>Expected Course Outcome:</b>   |  |                                      |
| Upon completion of this lab course, the students                            |  |                                      |
| 1.  | At the completion of this course, students will be able to do independent research at national and international standard. | K3, K4, K5, K6                       |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**



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**M.Sc. Zoology Course - SEMESTER-IV**  
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**AQUACULTURE**

**Elective Paper-VI**

**Paper Code: 23UPZOO1E11**

**Total Contact Hours: 72**

**Credits: 3**

**Weekly Contact Hours: 4**

|   |  |                    |
|---|--|--------------------|
| <b>Course Objectives:</b>   |  |                    |
| The main objectives of this course are:   |  |                    |
| <b>1.</b>   | Students should know basic concepts in Aquaculture.  |                    |
| <b>Course</b>   | :  | <b>Elective-VI</b> |
| <b>Course title</b>   | :  | <b>Aquaculture</b> |
| <b>Credits</b>  | :  | <b>3</b>           |
| <b>Pre-requisite:</b>   |  |                    |
| Students should know the fin fishes and shell fishes of commercially important candidate species. |  |                    |
| <b>Expected Course Outcome:</b>   |  |                    |
| Upon completion of this course, Students would have   |  |                    |
| I   | To develop knowledge on the fish farm and their maintenance. Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques | <b>K1 &amp; K2</b> |
| II  | To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval culture                 | <b>K3 &amp; K4</b> |
| III   | Identifies the different fishes diseases, diagnosis and their management strategies. Understands Ornamental fishes and central aquaculture organizations           | <b>K5 &amp; K6</b> |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | Importance of aquaculture- Present status, prospects and scope in India. Freshwater aquaculture- Brackishwater aquaculture- Mariculture - Metahaline culture in India. Types of fish culture -Types of fish ponds for culture practice. Topography, site selection - water quality - soil condition and quality – structure and construction design and layout - inlet and outlet. Water quality management for aquaculture. Control of parasites, predators and weeds in culture ponds. Fish farm implements - Secchi disc - aerator - pH meter - tools for hypophysation - feeding trays – Fishing gears and crafts used in aqua farming. |
| <b>II</b>    | Procurement of seed from natural resources- collection methods and segregation. Hatchery technology for major carps and freshwater prawn. Artificial seed production –Breeding under control conditions, induced breeding technique, larval rearing, packing and transportation Commercial substitute for pituitary extracts. Classification of fish feed- Artificial feeds Types, Feed - formulation - feeding methods. Live feed- Microalgae, Rotifer, Artemia and their culture.   |
| <b>III</b>   | Shrimp hatchery technology - Hatchery design, brood stock management, spawning, larval rearing, Shrimp developmental stages, algal culture, packing and transportation. Shrimp culture technology - extensive culture methods semi- intensive - intensive culture methods - Biofloc technology - Culture operations (water quality, feed and health management) -   |

|   |  |
|---|--|
|   | harvesting, preservation and marketing. Brackish water fish culture. Edible and Pearl oyster culture - pearl production. Crab culture. Economic importance of Lobster, Sea urchin and Sea cucumber - their by-products. Types of Seaweeds - species and methods of culture – by-products             |
| <b>IV</b>   | Fish and Shrimp diseases and health management – infectious diseases - Bacterial, Fungal, Viral, Protozoan; Non-infectious - environmental and nutritional diseases. Diseases diagnosis, prevention and control measures. Fish processing and preservation.  |
| <b>V</b>  | Types of ornamental fishes (freshwater and marine), their breeding behavior and biology. Oviparous, Ovo-viviparous and Viviparous fishes. Setting and maintenance of freshwater Aquarium tanks. Central aquaculture research organizations- CMFRI, CIBA, CIFT, CIFA, CIFE, MPEDA and its activities. |
| <b>Reading list</b>   |  |
| <ol style="list-style-type: none"> <li>1. Pillay, T. V. R. (1990). Aquaculture: Principles and Practices. Blackwell Scientific Publications Ltd.</li> <li>2. Santhanam, R. (1990). Fisheries Science. Daya Publishing House.</li> <li>3. Sinha, V.R. P. and Srinivastava, H. C. (1991). Aquaculture Productivity. Oxford and IBH Publications CO., Ltd., New Delhi.</li> <li>4. Yadav, B. N. (1997). Fish and fisheries. Daya Publishing house, New Delhi.</li> </ol>                           |  |
| <b>Recommended texts</b>  |  |
| <ol style="list-style-type: none"> <li>1. Das M. C. and Patnaik, P. N. (1994) Brackish water culture. Palani paramount Publications, Palani, T. N.</li> <li>2. Day, F (1958). Fishes of India , VoL I and Vol. II. William Sawson and Sons Ltd., London.</li> <li>3. Jhingran, V. G. (1991). Fish and Fisheries of India. Hindustan Publishing Co., India</li> <li>4. Maheswari. K. (1983) Common fish disease and their control. Institute of Fisheries Education, Powarkads (M.P).</li> </ol> |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | M          | S          | S          | S          | M          | M          | S           |
| <b>CO2</b>                              | S          | S          | S          | M          | S          | S          | S          | M          | S          | S           |
| <b>CO3</b>                              | S          | S          | S          | S          | S          | S          | S          | S          | S          | M           |
| <b>CO4</b>                              | S          | S          | M          | S          | S          | S          | S          | M          | M          | S           |
| <b>CO5</b>                              | S          | S0         | M          | S0         | M          | S          | M          | L          | S          | S           |

\*S-Strong; M-Medium; L-Low



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**VERMICULTURE**

**Elective Paper-VI**

**Paper Code: 23UPZOO1E12**

**Total Contact Hours: 72**

**Credits: 3**

**Weekly Contact Hours: 4**

|   |   |                        |
|---|---|------------------------|
| <b>Course Objectives:</b>   |   |                        |
| The main objectives of this course are:                                       |   |                        |
| 1.  | Students should know basic concepts in Vermiculture.  |                        |
| <b>Course</b>   | :   | <b>Elective-VI</b>     |
| <b>Course title</b>   | :   | <b>Vermiculture</b>    |
| <b>Credits</b>  | :   | <b>3</b>               |
| <b>Pre-requisite:</b>   |   |                        |
| Students should be aware of economic and cultural importance of Vermiculture. |   |                        |
| <b>Expected Course Outcome:</b>   |   |                        |
| Upon completion of this course, Students would have                           |   |                        |
| I   | To understand the various practices in vermiculture. To know the needs for Vermiculture and the status of India in global market. | <b>K2 &amp; K3</b>     |
| II  | Able to apply the techniques and practices needed for vermiculture.   | <b>K1, K2 &amp; K4</b> |
| III   | To know the difficulties in Vermiculture and be able to propose plans against it.   | <b>K5 &amp; K6</b>     |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b>        |   |
|---------------------|---|
| <b>I</b>            | Earthworms - Taxonomic position, Ecological grouping – Epigeic, Anecic and Endogeic species; morphology and anatomical features - shape, size, colour, segmentation, setae & clitellum. Body wall, coelom- locomotion, digestive, circulatory, respiratory, excretory & nervous system. Reproductive system-Male & Female, copulation, cocoon formation & fertilization, development of earthworm. Vermitechnology- Definition, history, growth and development in other countries & India, significance.                                 |
| <b>II</b>           | Vermitechnology- Definition, history, growth and development in India and other countries. Vermiculture - definition, common species for culture; Environmental parameters; culture methods – wormery - breeding techniques; indoor and outdoor cultures - monoculture and polyculture - merits and demerits. Vermibed preparation.   |
| <b>III</b>          | Methods of Vermicomposting - Vermicomposting of wastes in field pits, ground heaps, tank method – Four tank, well ring method, HDPE Bag method, roof shed method, static pile windrows, top fed windrows, wedges & bin method, harvesting the compost, storage.   |
| <b>IV</b>           | Applications of vermiculture - Vermiculture Bio-technology, vermicomposting, use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected industrial sludge; biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration. Vermiwash preparation and application.  |
| <b>V</b>            | Prospects of vermiculture as a self-employment venture. Potentials and constraints for vermiculture in India. Marketing the products of vermiculture - quality control, market research, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing. Economic importance of Earthworms: in sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food. |
| <b>Reading list</b> |   |

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. Edwards, C.A. 2004. Earthworm Ecology. CRC Press, Boca Raton, FL.
4. Ismail, S.A. 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
5. Ismail, S.A. 1997. Vermicology: The Biology of Earthworms, Orient Longman, India.

**Recommended texts**

1. <https://agritech.tnau.ac.in/sericulture/>
2. <https://www.agrifarming.in/vermiculture-process-techniques-worm-farming>
3. 11. Edwards, C.A., and Bother, B., 1996. Biology of earthworms, Chapman Hall Publication company.

**Mapping with Programme Outcomes\***

| COs | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 |
|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|
| CO1 | L   | M   | L   | L   | L   | L   | S   | L   | L   | L    |
| CO2 | L   | S   | S   | S   | S   | S   | L   | S   | S   | S    |
| CO3 | M   | S   | S   | S   | S   | S   | L   | S   | S   | L    |
| CO4 | L   | S   | S   | S   | M   | S   | M   | S   | S   | M    |
| CO5 | S   | S   | M   | S   | L   | L   | L   | M   | L   | M    |

\*S - Strong; M - Medium; L- Low



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### INTELLECTUAL PROPERTY RIGHTS

**Skill Enhancement Course (SEC) - III**

**Paper Code: 23UPZOO1S03**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|   |   |   |
|---|---|---|
| <b>Course Objectives:</b>   |   |   |
| The main objectives of this course are:   |   |   |
| 1.  | Students should gain basic knowledge intellectual property.   |   |
| <b>Course</b>   | :   | <b>Skill Enhancement Course (SEC) - III</b> |
| <b>Course title</b>   | :   | <b>Intellectual Property Rights</b>         |
| <b>Credits</b>  | :   | <b>2</b>                                    |
| <b>Pre-requisite:</b>   |   |   |
| Students should be aware of importance of analysis of quantitative and qualitative information from biological studies. |   |   |
| <b>Expected Course Outcome:</b>   |   |   |
| On the successful completion of the course, student will be able to   |   |   |
| I   | Claim the rights for the protection of their invention done in their project work.  | <b>K1 &amp; K3</b>                          |
| II  | Identify criterias' to fit one's own intellectual work in particular form of IPRs   | <b>K4 &amp; K5</b>                          |
| III   | To get registration in our country and foreign countries of their invention, designs and thesis or theory written by students during their project. | <b>K1, K2 &amp; K3</b>                      |

**K1-** Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

| Units  |  |
|--|--|
| <b>I</b>   | Introduction to IPRs, Basic concepts and need for Intellectual Property Rights- Patents, Copyrights, Geographical Indications, IPR in India and Abroad - Genesis and Development - the way from WTO to WIPO - TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations - Important examples of IPR. |
| <b>II</b>  | Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad  |
| <b>III</b>   | International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.   |
| <b>IV</b>  | Digital Innovations and Developments as Knowledge Assets - IP Laws, Cyber Law and Digital Content Protection - Unfair Competition - Meaning and Relationship between Unfair Competition and IP Laws - Case Studies.  |
| <b>V</b>   | Infringement of IPRs, Enforcement Measures, Emerging issues - Case Studies.  |
| <b>Reading list</b>  |  |
| 1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.<br>2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.<br>3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013. |  |
| <b>Recommended texts</b>   |  |
| 1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012<br>2. S.V Satakar Intellectual property Rights and Copy Rights, Ess Publication, New Delhi, 2002.   |  |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | M          | M          | S          | S          | M          | M          | M           |
| <b>CO2</b>                              | S          | S          | M          | S          | M          | S          | S          | S          | M          | L           |
| <b>CO3</b>                              | S          | M          | M          | S          | M          | L          | L          | S          | L          | S           |
| <b>CO4</b>                              | M          | M          | S          | L          | M          | S          | S          | S          | S          | S           |
| <b>CO5</b>                              | M          | S          | S          | L          | S          | M          | M          | L          | L          | S           |

\*S - Strong; M - Medium; L – Low



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### EXTENSION ACTIVITY

Extension Activity

Paper Code: 23UPZOO1X01

Credits: 1

|  |  |                           |
|--|--|---------------------------|
| <b>Course Objectives:</b>  |  |                           |
| The main objectives of this course are:  |  |                           |
| 1.   | To train general public, farmers and school children on vermicomposting and vermiculture.  |                           |
| 2.   | To bring social awareness on vector-borne diseases like malaria, filariasis and dengue.  |                           |
| <b>Course</b>  | :  | <b>Extension Activity</b> |
| <b>Course title</b>  | :  | <b>Extension Activity</b> |
| <b>Credits</b>   | :  | <b>1</b>                  |
| <b>Pre-requisite:</b>  |  |                           |
| To gain professional learning experience and develop new skills in life science field. |  |                           |
| <b>Expected Course Outcome:</b>  |  |                           |
| Upon completion of this lab course, the students                                       |  |                           |
| 1.   | At the completion of this course, students will be able to train public on vermicomposting and awareness on vector-borne diseases. | K3, K4, K5, K6            |

**K1-** Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create



## **VALUE-ADDED COURSES**



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**3D CELL CULTURE AND TISSUE ENGINEERING**  
 (Extra Credit Paper: Online Mode Certificate Course)

**Value Added Course-01**

**Paper Code: 23UPZOO1V01**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|  |   |   |
|--|---|---|
| <b>Course Objectives:</b>  |   |   |
| The main objectives of this course are:  |   |   |
| 1.   | Main objective is to provide in-depth knowledge on the cell culture methods to the students.  |   |
| <b>Course</b>  | :   | <b>Value Added Course [VAC] - I</b>           |
| <b>Course title</b>  | :   | <b>3D Cell Culture and Tissue Engineering</b> |
| <b>Credits</b>   | :   | <b>2</b>                                      |
| <b>Pre-requisite:</b>  |   |   |
| Students should have basic knowledge in cell and molecular biology.                            |   |   |
| <b>Expected Course Outcome:</b>  |   |   |
| Upon completion of this course, Students would have  |   |   |
| I  | A strong foundation on the cell culture methods by students.  | <b>K1 &amp; K2</b>                            |
| II   | Students gain knowledge about advance methods like 3D cell culture.   | <b>K3 &amp; K4</b>                            |
| III  | Students can become an expert in the application of 3D cell culture and tissue engineering.   | <b>K1, K4 &amp; K5</b>                        |
| <b>K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create</b>            |   |   |
| <b>Units</b>   |   |   |
| <b>I</b>   | History and Scope for Animal cell culture. Evolution of 3D cell culture techniques. Comparison of 2D and 3D cell culture. Applications of Cell culture in Drug discovery, Disease diagnosis and treatment.  |   |
| <b>II</b>  | Laboratory setup of 3 D cell culture – Principle and applications of Microfluidic System, CO <sub>2</sub> incubator, Live Cell Imaging Microscope and Confocal Microscope. Significance of 3D Bioprinting and types of Bio-inks.  |   |
| <b>III</b>   | 3D Cell culture methods: Hanging drop, Non-adhesive wells, Rotating wall vessel, Micro-fluidics, Magnetic levitation, Aqueous two-phase system. Advantage and disadvantage of 3D cell culture methods.  |   |
| <b>IV</b>  | Hydrogel preparation and utilization for Scaffold culture, scaffold-free culture, culturing on natural polymers and synthetic polymers. Tissue Engineering: Types and Applications.   |   |
| <b>V</b>   | Applications of 3D Cell Culture: Drug Designing, Organoids, Disease modeling, Bio-banking and Precision Medicine, Regenerative Medicine and Assembloids. Current Scenario of Organ on chip and human on chip research in tissue engineering and Translational medicine. |   |
| <b>Reading list</b>  |   |   |
| 1. Mark J. Suto et al., 2012. 3D Cell Culture. First Edition, Elsevier Publication, USA.       |   |   |
| 2. Jose A. Andrades, 2013. Regenerative Medicine and Tissue Engineering, Intech open access.   |   |   |
| <b>Recommended texts</b>   |   |   |
| 1. Xiaowen Wu et al., 2021. Recent Advances in Three-Dimensional Stem Cell Culture Systems and |   |   |

Applications. Stem Cell International.

2. Amanda Marchini and Fabrizio Gelain, 2021. Synthetic scaffolds for 3D cell cultures and organoids: applications in regenerative medicine. Crit Rev Biotechnol. 1-19. 2021. 1932716.

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | M          | L          | L          | M          | M          | L          | L           |
| <b>CO2</b>                              | S          | M          | L          | L          | S          | L          | M          | M          | L          | M           |
| <b>CO3</b>                              | M          | L          | M          | L          | S          | S          | M          | S          | M          | S           |
| <b>CO4</b>                              | S          | S          | S          | S          | M          | S          | L          | L          | L          | M           |
| <b>CO5</b>                              | S          | L          | L          | L          | M          | L          | L          | S          | M          | S           |

\*S - Strong; M - Medium; L- Low



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**DEPARTMENT OF ZOOLOGY**  
 Salem-636011, Tamil Nadu

**M.Sc. Zoology Course**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**GENOTOXICOLOGY**  
 (Extra Credit Paper: Online Mode Certificate Course)

**Value Added Course-02**

**Paper Code: 23UPZOO1V02**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|  |   |                                      |
|--|---|--------------------------------------|
| <b>Course Objectives:</b>                                    |   |                                      |
| The main objectives of this course are:                      |   |                                      |
| 1.   | Students should understand basic concepts in Genotoxicology.  |                                      |
| <b>Course</b>  | :   | <b>Value Added Course [VAC] - II</b> |
| <b>Course title</b>  | :   | <b>Genotoxicology</b>                |
| <b>Credits</b>   | :   | <b>2</b>                             |
| <b>Pre-requisite:</b>  |   |                                      |
| Students should understand basic concepts in Genotoxicology. |   |                                      |
| <b>Expected Course Outcome:</b>                              |   |                                      |
| Upon completion of this course, Students would have          |   |                                      |
| I  | Students can understand genetic toxicology, genetic damages, genotoxic agents and their biological effects in humans. | <b>K1 &amp; K2</b>                   |
| II   | Students can understand different genotoxic carcinogens and various assays in genetic toxicity.                       | <b>K3 &amp; K4</b>                   |
| III  | Various genetic tests used in chromosomal abnormalities will be known.  | <b>K1, K4 &amp; K5</b>               |
| IV   | Assays to study gene mutations including mammalian cells in culture.  | <b>K3 &amp; K4</b>                   |
| V  | Genotoxic agents in agriculture especially pesticides using various plant assays will be known.                       | <b>K4 &amp; K5</b>                   |

**K1-** Remember; **K2-** Understand; **K3-** Apply; **K4-**Analyze; **K5-**Evaluate; **K6-** Create

| <b>Units</b>             |   |
|--------------------------|---|
| <b>I</b>                 | Role of genetic toxicology in health effect testing – DNA damage and repair – Mutagenesis and carcinogenesis – Consequence of genotoxicity in humans.   |
| <b>II</b>                | Classification of genotoxic agents – Genotoxic carcinogens. <i>In vitro</i> clastogenicity – mammalian chromosomal aberration assay; micronucleus assay (human lymphocytes); <i>In vivo</i> clastogenicity – rodent dominant lethal test and mouse heritable translocation assay. |
| <b>III</b>               | Chromosome aberration – mammalian spermatogonial chromosome aberration test, <i>in vivo</i> chromosomal aberration tests – rodent bone marrow chromosomal effects. DNA damage – Sister chromatid exchange in mammalian cells.   |
| <b>IV</b>                | Gene mutation in <i>Saccharomyces cerevisiae</i> ; <i>in vitro</i> cytogenetic assay – mitotic recombination in <i>S. cerevisiae</i> . Comet assay, Mammalian cells in culture – CHO <i>HGPRT</i> gene mutation assay, V79 <i>HGPRT</i> gene mutation assay.                      |
| <b>V</b>                 | Genotoxic agents in agro-ecosystem – mutagenicity and carcinogenicity of pesticides. Plant dependent mutation assays – <i>Allium cepa</i> assay, <i>Vicia faba</i> assay.   |
| <b>Reading list</b>      |   |
| 1                        | Brusick, D. 2013. Principles of Genetic Toxicology. Springer Publications.  |
| 2                        | Proudlock, R. 2016. Genetic Toxicology Testing – A Laboratory Manual. Elsevier-Academic Press.  |
| <b>Recommended texts</b> |   |
| 1                        | Fleck, R.F. 2012. Genetic Toxicology: An Agricultural Perspective. Springer Verlag.   |
| 2                        | EHC 240: Principles for Risk Assessment of Chemicals in Food. A joint publication of the Food and   |

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | M          | L          | L          | M          | M          | L          | L           |
| <b>CO2</b>                              | S          | M          | L          | L          | S          | L          | M          | M          | L          | M           |
| <b>CO3</b>                              | M          | L          | M          | L          | S          | S          | M          | S          | M          | S           |
| <b>CO4</b>                              | S          | S          | S          | S          | M          | S          | L          | L          | L          | M           |
| <b>CO5</b>                              | S          | L          | L          | L          | M          | L          | L          | S          | M          | S           |

\*S - Strong; M - Medium; L- Low



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**M.Sc. Zoology Course**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**INSECT-HOST INTERACTION**  
 (Extra Credit Paper: Online Mode Certificate Course)

**Value Added Course-03**

**Paper Code: 23UPZOO1V03**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|   |   |                                       |
|---|---|---------------------------------------|
| <b>Course Objectives:</b>   |   |                                       |
| The main objectives of this course are:   |   |                                       |
| 1.  | To gain knowledge about the insect plant interaction communication  |                                       |
| <b>Course</b>   | :   | <b>Value Added Course [VAC] - III</b> |
| <b>Course title</b>   | :   | <b>Insect-Host Interaction</b>        |
| <b>Credits</b>  | :   | <b>2</b>                              |
| <b>Pre-requisite:</b>   |   |                                       |
| To gain knowledge about the insect plant interaction communication                  |   |                                       |
| <b>Expected Course Outcome:</b>   |   |                                       |
| Upon completion of this course, Students would have                                 |   |                                       |
| I   | At the end of the semester, students will be able to understand pest insects.   | <b>K1 &amp; K2</b>                    |
| II  | Gain knowledge about monitoring insect pests and control measures.  | <b>K3 &amp; K4</b>                    |
| III   | Students can predict vector-borne diseases and its prevalence.  | <b>K1, K4 &amp; K5</b>                |
| <b>K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create</b> |   |                                       |
| <b>Units</b>  |   |                                       |
| <b>I</b>  | Classification of Insects. External morphology of Insects- Life cycle of insects – Types of metamorphosis.  |                                       |
| <b>II</b>   | Insects as vectors of plant pathogens. Important insect vectors and their characteristics; mouth parts and feeding processes of important insect vectors. Efficiency of transmission. |                                       |
| <b>III</b>  | Transmission of plant viruses and fungal pathogens. Relation between viruses and their vectors.   |                                       |
| <b>IV</b>   | Transmission of bacterial pathogens by insects. Epidemiology and management of insect transmitted diseases through vector management.   |                                       |
| <b>V</b>  | Cultural, Chemical, Mechanical, biological pest management.   |                                       |
| <b>Reading list</b>   |   |                                       |
| 1   | Aslam Khan Md, Wasim Ahmad, 2019. Microbes for Sustainable Insect Pest Management, Springer publications  |                                       |
| 2   | Gullan, P.J., Cranston, P.S., 2014. The Insects: An Outline of Entomology, 5th Edition, Wiley publications  |                                       |
| 3   | Snodgrass, 2004. Principles Of Insect Morphology, Cbs Publishers, India.  |                                       |
| 4   | Chapman, R.F., Simpson, S.J., Douglas, A.E., 2013. The Insects: Structure And Function, 5th Edition, Cambridge University Press.  |                                       |
| <b>Recommended texts</b>  |   |                                       |
| 1.  | Imms, A.D., Richards, O.W., Davies, R.G., 1977. IMMS' General Textbook of Entomology, Structure, Physiology and Development. Springer publications                                    |                                       |
| 2.  | Oakeshott, J., Whitten, M.J., 1993. Molecular Approaches to Fundamental and Applied Entomology. Springer publications   |                                       |

3. Ananthkrishnan, T.N., 2007. Dimensions of Molecular Entomology, Universities Press, Hyderabad, India
4. Basu AN. 1995. Bemisiatabaci (Gennadius) - Crop Pest and Principal Whitefly Vector of Plant Viruses. Oxford & IBH, New Delhi.
5. Harris KF & Maramarosh K. (Eds.). 1980. Vectors of Plant Pathogens. Academic Press, London.
6. Maramorosch K & Harris KF. (Eds.). 1979. Leafhopper Vectors and Plant Disease Agents. Academic Press, London.
7. Youdeovei A & Service MW. 1983. Pest and Vector Management in the Tropics. English Language Books Series, Longman, London.

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | M          | L          | L          | M          | M          | L          | L           |
| <b>CO2</b>                              | S          | M          | L          | L          | S          | L          | M          | M          | L          | M           |
| <b>CO3</b>                              | M          | L          | M          | L          | S          | S          | M          | S          | M          | S           |
| <b>CO4</b>                              | S          | S          | S          | S          | M          | S          | L          | L          | L          | M           |
| <b>CO5</b>                              | S          | L          | L          | L          | M          | L          | L          | S          | M          | S           |

\*S - Strong; M - Medium; L- Low



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**M.Sc. Zoology Course**  
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**MEDICAL ENTOMOLOGY**  
 (Extra Credit Paper: Online Mode Certificate Course)

**Value Added Course-04**

**Paper Code: 23UPZOO1V04**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|  |  |                                      |
|--|--|--------------------------------------|
| <b>Course Objectives:</b>  |  |                                      |
| The main objectives of this course are:  |  |                                      |
| 1.   | Main objective is to provide in-depth knowledge on the vector insects that cause various diseases to human and animals |                                      |
| <b>Course</b>  | :  | <b>Value Added Course [VAC] - IV</b> |
| <b>Course title</b>  | :  | <b>Medical Entomology</b>            |
| <b>Credits</b>   | :  | <b>2</b>                             |
| <b>Pre-requisite:</b>  |  |                                      |
| Main objective is to provide in-depth knowledge on the vector insects that cause various diseases to human and animals |  |                                      |
| <b>Expected Course Outcome:</b>  |  |                                      |
| Upon completion of this course, Students would have  |  |                                      |
| I  | Strong foundation on the disease transmitting insects will be laid.  | <b>K1 &amp; K2</b>                   |
| II   | You will be an expert and public advisor in insect transmitted diseases.   | <b>K3 &amp; K4</b>                   |
| III  | Study on this topic fits you for leading pesticide companies and advisor for insect pest management.                   | <b>K1, K4 &amp; K5</b>               |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b> |   |
|--------------|---|
| <b>I</b>     | <b>Introduction to Disease Transmitting Insects:</b> Classification of Vectors - Human vectors and Animal vectors. Vector borne diseases and control. Forensic application of insects |
| <b>II</b>    | <b>Insect morphology and metamorphosis:</b> Structure of egg, larvae, pupa and adult insects. Types of mouthparts, Antennae, wings and legs. Types of metamorphosis in insects.       |
| <b>III</b>   | <b>Mosquitoes and mosquito borne diseases</b> - Mosquito life cycle. Mosquito feeding behavior. <i>Anopheles</i> , <i>Aedes</i> and <i>Culex</i> – Malaria, Dengue and Filariasis.    |
| <b>IV</b>    | <b>Other Vectors and vector borne diseases:</b> Sand flies, Bugs – Human bugs, lice & fleas. Life cycle of Housefly and Cockroach.  |
| <b>V</b>     | <b>Vector Control</b> –Integrated vector control program. Chemical, Physical and Botanical control. Synthesis of Metal Nanoparticles for insect vector control.                       |

**Reading list**

1. Mike Service, 2008. Medical Entomology for Students. Cambridge University Press, R. F. Chapman, 1998. The *Insects*: Structure and Function. Cambridge University Press.
2. Isaac Ishaaya, Subba Reddy Palli, A. Rami Horowitz, 2012. Advanced Technologies for Managing Insect Pests. Springer.
3. B.F. Eldridge, J.D. Edman, 2003. Medical Entomology: A Textbook on Public Health and Veterinary Problems Caused by Arthropods. Springer.

**Recommended texts**

1. Chapman, M. W. Service, Hall 1993. Mosquito Ecology: Field Sampling Methods. Chapman & Hall



- publishers.
2. Arun Kumar; Heidi M. Mansour; Adam Friedman; Eric R. Blough 2013. Nanomedicine in Drug Delivery. CRC Press.
  3. B. K. Tyagi, 2008. Vector-borne diseases: epidemiology and control. Scientific Publishers.

| <b>Mapping with Programme Outcomes*</b> |            |            |            |            |            |            |            |            |            |             |
|---|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>COs</b>                              | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
| <b>CO1</b>                              | S          | S          | M          | M          | L          | L          | M          | M          | L          | L           |
| <b>CO2</b>                              | S          | M          | L          | L          | S          | L          | M          | M          | L          | M           |
| <b>CO3</b>                              | M          | L          | M          | L          | S          | S          | M          | S          | M          | S           |
| <b>CO4</b>                              | S          | S          | S          | S          | M          | S          | L          | L          | L          | M           |
| <b>CO5</b>                              | S          | L          | L          | L          | M          | L          | L          | S          | M          | S           |

\*S - Strong; M - Medium; L- Low

## **ADD-ON COURSES**



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**M.Sc. Zoology Course**  
 (This syllabus is applicable to the students who are admitted on or after 2023-2024 academic year onwards)

**PCR TECHNOLOGY**  
 (Extra Credit Paper: Online Mode Certificate Course)

**Add-On Course-01**

**Paper Code: 23UPZOO1A01**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|   |   |                                |
|---|---|--------------------------------|
| <b>Course Objectives:</b>   |   |                                |
| The main objectives of this course are:   |   |                                |
| 1.  | To provide knowledge on the concept of PCR and its uses and to identify various diseases using PCR Technology.  |                                |
| <b>Course</b>   | :   | <b>Add-On Course [AOC] - I</b> |
| <b>Course title</b>   | :   | <b>PCR Technology</b>          |
| <b>Credits</b>  | :   | <b>2</b>                       |
| <b>Pre-requisite:</b>   |   |                                |
| To provide knowledge on the concept of PCR and its uses and to identify various diseases using PCR Technology.      |   |                                |
| <b>Expected Course Outcome:</b>   |   |                                |
| Upon completion of this course, Students would have   |   |                                |
| I   | Understand the basic principle of PCR reaction and types and uses of PCR Machine.   | <b>K1 &amp; K2</b>             |
| II  | Diagnose various diseases causing culprits at gene level.   | <b>K3 &amp; K4</b>             |
| III   | Understand various applications of PCR techniques in industries & Clinical Laboratories.  | <b>K4 &amp; K5</b>             |
| IV  | Processing of Biopsy samples using PCR Kit.   | <b>K4</b>                      |
| V   | Become an entrepreneur by developing PCR kit.   | <b>K4 &amp; K5</b>             |
| <b>K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create</b>                                 |   |                                |
| <b>Units</b>  |   |                                |
| I   | History, scope and future prospects of polymerase chain reaction- Invention of PCR Machine and advances in PCR Instrumentation, Working principle of PCR.   |                                |
| II  | Types and Evolution of PCR: qPCR, RT-PCR, Ong PCR, Nested PCR, Inverse PCR, Hot Start PCR, Multiplex PCR, and Solid State PCR.  |                                |
| III   | Sample preparation and handling of chemicals and reagents in PCR laboratory- Bio-safety measures, Good Laboratory Practices.  |                                |
| IV  | Processing of biopsy samples-DNA/RNA isolation and identification of DNA/RNA fragments- Agarose and Polyacrylamide Gel Electrophoresis.   |                                |
| 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). |                                |
| <b>Reading list</b>   |   |                                |
| 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. |   |                                |

**Recommended texts**

1. Mark A. Behlke, Kornelia Berghof-Jäger, Tom Brown (2019). Polymerase Chain Reaction: Theory and Technology Publisher: Caister Academic Press.
2. Thomas Weissensteiner Tania Nolan Stephen A. Bustin , Hugh G. Griffin Annette Griffin 3003 PCR Technology: Current Innovations, Second Edition (Weissensteiner, PCR Technology) CRC Press
3. Henry A. Erlich PCR Technology: Principles and Applications for DNA Amplification Palgrave Macmillan, London

**Mapping with Programme Outcomes\***

| <b>COs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b> | S          | S          | M          | M          | L          | L          | M          | M          | L          | L           |
| <b>CO2</b> | S          | M          | L          | L          | S          | L          | M          | M          | L          | M           |
| <b>CO3</b> | M          | L          | M          | L          | S          | S          | M          | S          | M          | S           |
| <b>CO4</b> | S          | S          | S          | S          | M          | S          | L          | L          | L          | M           |
| <b>CO5</b> | S          | L          | L          | L          | M          | L          | L          | S          | M          | S           |

\*S - Strong; M - Medium; L- Low



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**ORNITHOLOGY**  
 (Extra Credit Paper: Online Mode Certificate Course)

**Add-On Course-02**

**Paper Code: 23UPZOO1A02**

**Total Contact Hours: 36**

**Credits: 2**

**Weekly Contact Hours: 2**

|  |  |                                 |
|--|--|---------------------------------|
| <b>Course Objectives:</b>  |  |                                 |
| The main objectives of this course are:                                |  |                                 |
| 1.   | To know about the diversity of birds in and around Periyar University. |                                 |
| <b>Course</b>  | :  | <b>Add-On Course [AOC] - II</b> |
| <b>Course title</b>  | :  | <b>Ornithology</b>              |
| <b>Credits</b>   | :  | <b>2</b>                        |
| <b>Pre-requisite:</b>  |  |                                 |
| To know about the diversity of birds in and around Periyar University. |  |                                 |
| <b>Expected Course Outcome:</b>  |  |                                 |
| Upon completion of this course, Students would have                    |  |                                 |
| I  | Identify the birds present in and around Periyar University.           | <b>K1, K2 &amp; K3</b>          |
| II   | Learn on devices used for bird watching.                               | <b>K2 &amp; K3</b>              |
| III  | Recognize the birds through the calls emitted by them.                 | <b>K4 &amp; K5</b>              |
| IV   | Understand the conservation status of birds in India                   | <b>K3 &amp; K4</b>              |
| V  | To get placement in conservation agencies.                             | <b>K4 &amp; K5</b>              |

**K1- Remember; K2- Understand; K3- Apply; K4-Analyze; K5-Evaluate; K6- Create**

| <b>Units</b>   |  |
|--|--|
| <b>I</b>   | 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.                |
| <b>II</b>  | Bird Habitats Bird Counting/ Census-Bird Watching: Identification of Birds in flight, Identification through Calls and songs. Equipments used for Bird Watching.   |
| <b>III</b>   | Breeding behaviour of birds- Territoriality, Nest building behaviour, Egg laying and clutch size, Incubation and feeding young, weaning of young one and Brood parasitism.                                 |
| <b>IV</b>  | Activity recording and Ethogram- Flying, Walking, Eating, Perching on trees or wires, Drinking water, Singing, Nesting, Preening, Moulting, Bathing, Dust bath, Flocking, Roosting etc.,                   |
| <b>V</b>   | 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. |
| <b>Reading list</b>  |  |
| 1. Ali, S., Ripley, B.S 1990. A hand book of Birds of Indian sub-continent, Oxford University Press.                     |  |
| <b>Recommended texts</b>   |  |
| 1. Grimmet, R., Inskipp, T and Nameer, P.O. 2007. Birds of southern India, BNHS, Bombay.                                 |  |
| 2. Kazmierczak, K and van Perlo, B. 2000. A field guide to the birds of Indian subcontinent, Yale University Press, USA. |  |

**Mapping with Programme Outcomes\***

| <b>COs</b> | <b>PO1</b> | <b>PO2</b> | <b>PO3</b> | <b>PO4</b> | <b>PO5</b> | <b>PO6</b> | <b>PO7</b> | <b>PO8</b> | <b>PO9</b> | <b>PO10</b> |
|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-------------|
| <b>CO1</b> | S          | S          | M          | M          | L          | L          | M          | M          | L          | L           |
| <b>CO2</b> | S          | M          | L          | L          | S          | L          | M          | M          | L          | M           |
| <b>CO3</b> | M          | L          | M          | L          | S          | S          | M          | S          | M          | S           |
| <b>CO4</b> | S          | S          | S          | S          | M          | S          | L          | L          | L          | M           |
| <b>CO5</b> | S          | L          | L          | L          | M          | L          | L          | S          | M          | S           |

\*S - Strong; M - Medium; L- Low

## 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       |