

**Course Structure and Syllabus**  
**For students admitted from academic year 2025-26 onwards**

**(Regulations:R25)**



## Andhra Pradesh

10

#### ❖ VISION

- To strive for all round development of students for attainment of scientific empowerment both in teaching and research and self-reliant as well.
- To establish multi-institutional, interdisciplinary and international collaborations in thrust areas of scientific research so as to acquire national and international recognition.
- To develop advanced characterization facilities for cutting edge research with a roadmap towards the establishment of Centre for plant tissue culture.
- To strive for transformation of laboratory research towards industrial scale so as to acquire industrial collaboration and funding as well.

#### ❖ MISSION

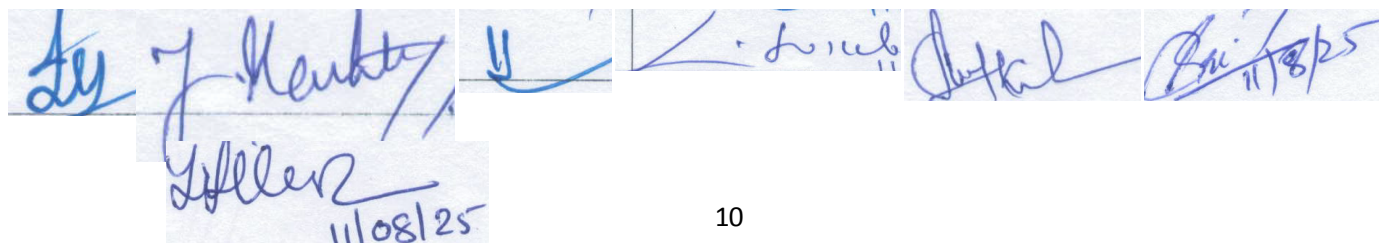
- Dissemination of knowledge through research-based teaching and learning processes with a motive to inculcate strong research attitude in student community.
- Build good character and educate students so as to become enlightened individuals, improving the living standards of their families and society.

#### ❖ PROGRAMME OBJECTIVES

- To develop the basic applied concepts in core areas of Zoology.
- To perform the basic and research-oriented experiments to inculcate the critical thinking with proper interpretation and analysis of results with logical thinking.
- To develop the critical analysis and problem-solving skills of students required in the application of principles of Zoology.
- To undertake small academic and/or research projects in the area of animal sciences and preparation of document/present a technical report/dissertation.
- To prepare the students with a working knowledge of experimental techniques required to work independently.
- To strengthen student's capability in organizing and presenting the acquired knowledge both in oral and written discourse.

#### ❖ PROGRAMME OUTCOMES

- Acquire knowledge and understanding of fundamental concepts, principles and theories related to the identified subject areas.
- Develop skills to interpret and explain the limits of accuracy of experimental data in terms of significance and underlying theory.
- Demonstrate written and oral communication skills for dissemination of scientific results in report, article, or oral presentation formats, which helps to develop his/her professional development.

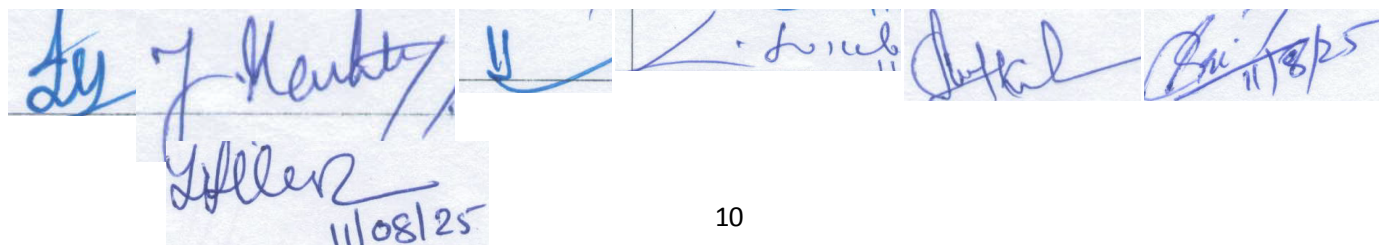


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## COURSE STRUCTURE AND REQUIREMENTS FOR M.Sc. ZOOLOGY

(REGULATION: R25)

|   |                                    |                                                                                                                                                                                                                                                           |
|---|------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Title of the Course                | M.Sc. ZOOLOGY                                                                                                                                                                                                                                             |
| 2 | Duration of the course             | 2 years (Four Semesters)                                                                                                                                                                                                                                  |
| 3 | Eligibility criteria for admission | The candidate seeking admission into M.Sc. Zoology Program should have passed Bachelor's Degree Examination not less than three years duration in any discipline with Zoology as one of the subjects or biological sciences with Zoology at 10+2 level.   |
| 4 | Level of the Course                | Post Graduate.                                                                                                                                                                                                                                            |
| 5 | Mode of Admission                  | The mode of admission is through APPGCET conducted by Andhra Pradesh State Council of Higher Education or KRUCET conducted by Krishna University                                                                                                          |
| 6 | Objectives of the course           | The Objective of M.Sc. Zoology course is to impart knowledge in basic concepts in core areas of Zoology as well as recent advances in Zoology, training in experimental skills with an aim to develop research in commercial and scientific applications. |
| 7 | Course requirements                | The course shall include theory (core as well as non-core, open electives, specializations) papers, Laboratories, Assignments, Tests, Seminars and Project Work.                                                                                          |
| 8 | Number of working days             | In each semester at least ninety (90) working days must be dedicated for theory classes, practical classes and seminars/project work.                                                                                                                     |

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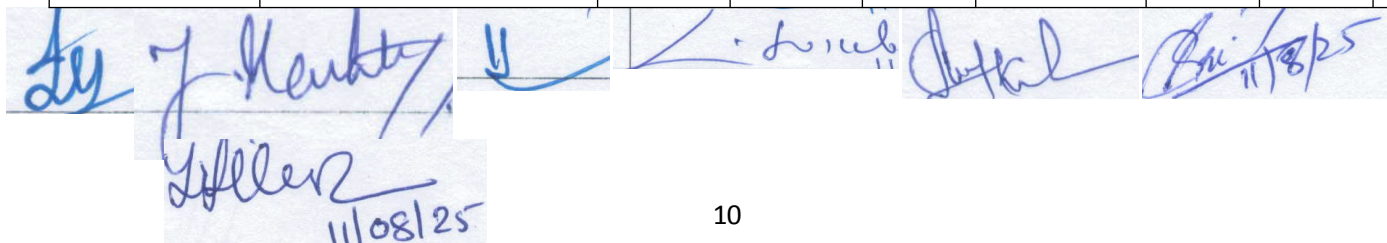
**KRISHNA UNIVERSITY: MACHILIPATNAM**  
**COURSE STRUCTURE FOR PG PROGRAMS (SCIENCE STREAM)**  
**UNDER CHOICE BASED CREDIT SYSTEM (CBCS) & OUTCOME BASED EDUCATION (OBE)**  
**W.E.F 2025-26 (R25 Regulations)**

**I.SEMESTER**

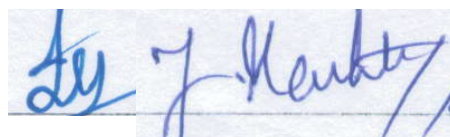
| Course Code                     | Course Name                                               | Teaching Hours/ week |           |          | CORE/ IDC/ DSE/ SEC/ OEC/MOOCs | Internal Marks | External Marks | No. of Credits |
|---------------------------------|-----------------------------------------------------------|----------------------|-----------|----------|--------------------------------|----------------|----------------|----------------|
|                                 |                                                           | Lecture              | Practical | Tutorial |                                |                |                |                |
| 25ZOO101                        | Cell Biology                                              | 4                    | 0         | 0        | Core                           | 30             | 70             | 4              |
| 25ZOO102                        | Genetics                                                  | 4                    | 0         | 0        | Core                           | 30             | 70             | 4              |
| 25ZOO103                        | Biomolecules                                              | 4                    | 0         | 0        | Core                           | 30             | 70             | 4              |
| 25ZOO104                        | Systematics of Invertebrates                              | 4                    | 0         | 0        | Core                           | 30             | 70             | 4              |
| <b>25 ZOO 105 Compulsory</b>    | Personality Development through Life Enlightenment Skills | 3                    | 1         | 0        | Core                           | 30             | 70             | 3              |
| 25ZOOL101                       | Cell Biology & Genetics                                   | 0                    | 6         | 0        | Core                           | 30             | 70             | 3              |
| 25ZOOL102                       | Biomolecules & Systematics of Invertebrates               | 0                    | 6         | 0        | Core                           | 30             | 70             | 3              |
| <b>TOTAL FOR FIRST SEMESTER</b> |                                                           |                      |           |          |                                | <b>210</b>     | <b>490</b>     | <b>25</b>      |

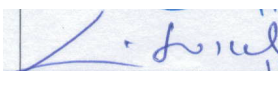
**II SEMESTER**

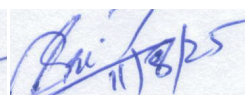
| Course Code                                       | Course Name                                            | Teaching Hours/ week |           |          | CORE / IDC/DSE/ SEC/OEC/ MOOCs | Internal Marks | External Marks | No. of Credits |
|---------------------------------------------------|--------------------------------------------------------|----------------------|-----------|----------|--------------------------------|----------------|----------------|----------------|
|                                                   |                                                        | Lecture              | Practical | Tutorial |                                |                |                |                |
| 25ZOO201                                          | Bioanalytical Techniques                               | 4                    | 0         | 0        | Core                           | 30             | 70             | 4              |
| 25ZOO202                                          | Systematics of Vertebrates & wildlife conservation     | 4                    | 0         | 0        | Core                           | 30             | 70             | 4              |
| 25ZOO203                                          | Anatomy of invertebrates and vertebrates               | 4                    | 0         | 0        | Core                           | 30             | 70             | 4              |
| 25ZOO204 Compulsory                               | Research Methodology & IPR                             | 3                    | 1         | 0        | SEC                            | 30             | 70             | 3              |
| DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE) |                                                        |                      |           |          |                                |                |                |                |
| 25ZOODSE201                                       | Comparative Animal Physiology                          | 4                    | 0         | 0        | DSE                            | 30             | 70             | 4              |
| 25ZOODSE202                                       | Toxicology                                             | 4                    | 0         | 0        | DSE                            | 30             | 70             | 4              |
| 25ZOODSE203                                       | Entomology                                             | 4                    | 0         | 0        | DSE                            | 30             | 70             | 4              |
| LAB PRACTICALS                                    |                                                        |                      |           |          |                                |                |                |                |
| 25ZOOL201                                         | Bioanalytical Techniques & Systematics of Vertebrates  | 0                    | 6         | 0        | Core                           | 30             | 70             | 3              |
| 25ZOOL202                                         | Anatomy of invertebrates and Vertebrates & Comparative | 0                    | 6         | 0        | Core                           | 30             | 70             | 3              |

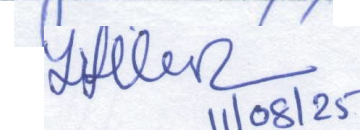

  
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|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|--|--|--|--|------------|------------|-----------|
|                                                                                                                                                                                                                                                                                                                                                                | Animal Physiology |  |  |  |  |            |            |           |
| <b>TOTAL FOR SECOND SEMESTER</b>                                                                                                                                                                                                                                                                                                                               |                   |  |  |  |  | <b>210</b> | <b>490</b> | <b>25</b> |
| At the end of 2 <sup>nd</sup> semester, every student must undergo summer Internship/ Apprenticeship/Project work/Industrial training/research-based Project work for Six weeks and must prepare a report concerned as per approved project guidelines & submit the same to the University 14 days before the commencement of third semester end examinations. |                   |  |  |  |  |            |            |           |







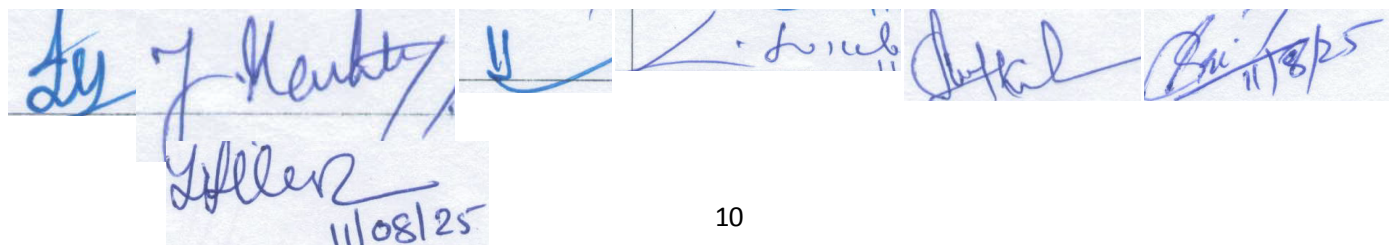


### III. SEMESTER

| Course Code                                                                         | Course Name                                                                     | Teaching Hours/ week |           |          | CORE /<br>IDC/DSE<br>/SEC/OE<br>C/MOOCs | Internal<br>Marks | External<br>Marks | No. of<br>Credits |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------|----------------------|-----------|----------|-----------------------------------------|-------------------|-------------------|-------------------|
|                                                                                     |                                                                                 | Lecture              | Practical | Tutorial |                                         |                   |                   |                   |
| 25ZOO301                                                                            | Molecular biology &<br>Animal Biotechnology                                     | 4                    | 0         | 0        | Core                                    | 30                | 70                | 4                 |
| <b>DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY THREE)</b>                          |                                                                                 |                      |           |          |                                         |                   |                   |                   |
| 25ZOODSE301                                                                         | Immunology and<br>Parasitology                                                  | 4                    | 0         | 0        | DSE                                     | 30                | 70                | 4                 |
| 25ZOODSE302                                                                         | Gamete Biology and<br>Endocrinology                                             | 4                    | 0         | 0        | DSE                                     | 30                | 70                | 4                 |
| 25ZOODSE303                                                                         | Ecology and animal<br>behaviour                                                 | 4                    | 0         | 0        | DSE                                     | 30                | 70                | 4                 |
| 25ZOODSE304                                                                         | rDNA Technology                                                                 | 4                    | 0         | 0        | DSE                                     | 30                | 70                | 4                 |
| 25ZOODSE305                                                                         | Dairy Technology                                                                | 4                    | 0         | 0        | DSE                                     | 30                | 70                | 4                 |
| 25ZOODSE306                                                                         | Limnology                                                                       | 4                    | 0         | 0        | DSE                                     | 30                | 70                | 4                 |
| <b>LAB PRACTICALS</b>                                                               |                                                                                 |                      |           |          |                                         |                   |                   |                   |
| 25ZOOLAB301                                                                         | Molecular biology &<br>Animal Biotechnology &<br>Immunology and<br>Parasitology | 0                    | 6         | 0        | Core                                    | 30                | 70                | 3                 |
| 25ZOOLAB302                                                                         | Gamete Biology and<br>Endocrinology & Ecology<br>and animal behaviour           | 0                    | 6         | 0        | Core                                    | 30                | 70                | 3                 |
| <b>OPEN ELECTIVE (INTERDISCIPLINARY/MULTIDISCIPLINARY) COURSES (CHOOSE ANY ONE)</b> |                                                                                 |                      |           |          |                                         |                   |                   |                   |
| 25ZOOOEC301                                                                         |                                                                                 | 3                    | 0         | 0        | OEC                                     | 30                | 70                | 3                 |
| 25ZOOOEC302                                                                         |                                                                                 | 3                    | 0         | 0        | OEC                                     | 30                | 70                | 3                 |
| 25ZOOOEC303                                                                         |                                                                                 | 3                    | 0         | 0        | OEC                                     | 30                | 70                | 3                 |
| <b>TOTAL FOR III - SEMESTER</b>                                                     |                                                                                 |                      |           |          |                                         | <b>210</b>        | <b>490</b>        | <b>25</b>         |

### IV SEMESTER

| Course Code                                                | Course Name                                     | Teaching Hours/ week |           |          | CORE/IDC/<br>DSE/SEC/<br>OEC/MOOCs | Internal<br>Marks | External<br>Marks | No. of<br>Credits |
|------------------------------------------------------------|-------------------------------------------------|----------------------|-----------|----------|------------------------------------|-------------------|-------------------|-------------------|
|                                                            |                                                 | Lecture              | Practical | Tutorial |                                    |                   |                   |                   |
| 25 ZOO401                                                  | Evolution & Population<br>genetics              | 4                    | 0         | 0        | Core                               | 30                | 70                | 4                 |
| <b>DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY THREE)</b> |                                                 |                      |           |          |                                    |                   |                   |                   |
| 25ZOODSE401                                                | Biotechnological<br>Applications in aquaculture | 4                    | 0         | 0        | DSE                                | 30                | 70                | 4                 |
| 25ZOODSE402                                                | Industrial Zoology                              | 4                    | 0         | 0        | DSE                                | 30                | 70                | 4                 |
| 25ZOODSE403                                                | Aquaculture Management &<br>Strategies          | 4                    | 0         | 0        | DSE                                | 30                | 70                | 4                 |
| 25ZOODSE404                                                | Shell fish culture                              | 4                    | 0         | 0        | DSE                                | 30                | 70                | 4                 |
| 25ZOODSE405                                                | Marine Bioactive compounds                      | 4                    | 0         | 0        | DSE                                | 30                | 70                | 4                 |
| 25ZOODSE406                                                | Sea food Processing                             | 4                    | 0         | 0        | DSE                                | 30                | 70                | 4                 |
| <b>LAB PRACTICALS</b>                                      |                                                 |                      |           |          |                                    |                   |                   |                   |


  
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|                                                                                                               |                                                                                  |   |   |   |      |            |            |           |
|---------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|---|---|---|------|------------|------------|-----------|
| 25ZOOL401                                                                                                     | Evolution & Population genetics and Biotechnological Applications in aquaculture | 0 | 6 | 0 | Core | 30         | 70         | 3         |
| <b>ENTREPRENEURIAL &amp; INNOVATION/IT SKILL RELATED TO DOMAIN SPECIFIC ELECTIVE COURSES (CHOOSE ANY ONE)</b> |                                                                                  |   |   |   |      |            |            |           |
| 25ZOOSEC401                                                                                                   | Apiculture & management                                                          | 3 | 0 | 0 | SEC  | 30         | 70         | 3         |
| 25ZOOSEC402                                                                                                   | Culturable finfishes                                                             | 3 | 0 | 0 | SEC  | 30         | 70         | 3         |
| 25ZOOSEC403                                                                                                   | Poultry                                                                          | 3 | 0 | 0 | SEC  | 30         | 70         | 3         |
| <b>* CHOOSE MOOCs FROM SWAYAM/NPTEL SOURCES</b>                                                               |                                                                                  |   |   |   |      |            |            |           |
| 25 ZOO MOOCS 401                                                                                              |                                                                                  |   |   |   |      |            |            | 4         |
| <b>25 ZOOP401-PROJECT WORK EVALUATION AND VIVA-VOCE</b>                                                       |                                                                                  |   |   |   |      | 100        |            | 4         |
| <b>TOTAL FOR IV SEMESTER</b>                                                                                  |                                                                                  |   |   |   |      | <b>180</b> | <b>520</b> | <b>30</b> |

### Open electives offered by dept of Biosciences & Biotechnology to the other departments

|             |                  |
|-------------|------------------|
| 25ZOOOEC301 | Honeybee Farming |
| 25ZOOOEC302 | Edible fishes    |
| 25ZOOOEC303 | Poultry          |

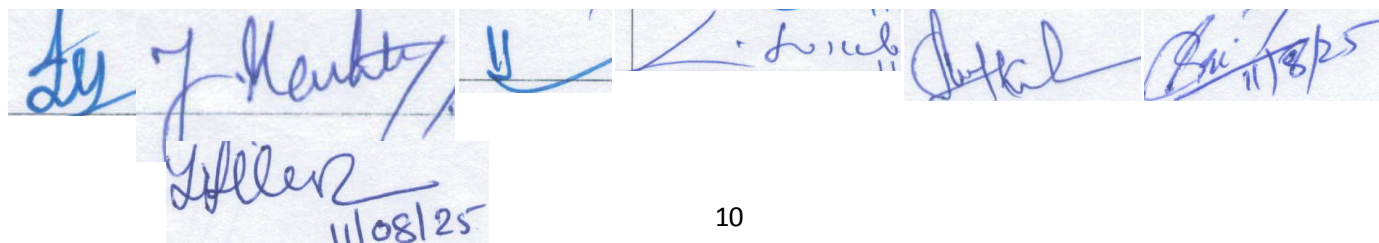
L – Lecture, T- Tutorial & P – Practicals

**Note:** Students may be allowed to register and appear for MOOCS from the third semester itself. However, students are to complete the MOOCS successfully and submit pass certificate of the same to the University through the Principal of the College concerned for approval and endorsement of the same on grade cards and PCs and ODs as per the regulations of the University.

### 25 ZOO P401: PROJECT WORK EVALUATION AND VIVA-VOCE

**A). Research activity:** A short research activity on any significant or interesting aspects of the works (preferably relevant to the students' field of study/specialization) has to be performed or observed by a student in the organization. As part of curriculum students are required to write a short report generally named as a Research activity under the guidance of supervisor.

**B). Purpose of Research activity:** The basic purpose of writing a Research activity is to allow students to explore the breadth of research that is performed within the organization. For students, this breadth of exposure to outside research may prove fruitful as a platform for their own research at some later point (can be extended to as a thesis topic for Ph.D. degree) and also for career connections/employment opportunities prior to post graduation through demonstrating their competences in research techniques. It is up to the student to choose/select the title/topic for Research activity from any interesting aspects of their duties they are involved. However, the supervisor may also assist the student in selecting the Research Activity Report title that can satisfy him/her expectation as well as it is related to the student's fields of study. It is expected that the supervisor stays in regular contact with the student for monitoring


  
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KRISHNA UNIVERSITY: : MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, I SEMESTER**

| Course Name | CELL BIOLOGY | L | T | P | C | IM | EM | TM  |
|-------------|--------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOO101     | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:**

The focus of Cell Biology is the study of the structure and function of the cell. In this course we will focus on Eukaryotic cell biology and will cover topics such as membrane structure and composition, transport, and trafficking; the cytoskeleton and cell movement; the breakdown of macromolecules and generation of energy; and the integration of cells into tissues. We will also cover important cellular processes such as cell cycle regulation, signal transduction, apoptosis (programmed cell death), and cancer cell biology.

❖ **Course Learning Objective(s):**

- To make the learners understand the functional aspects of the cell at molecular level.
- To focus on the up-coming molecular mechanisms involving the membrane organization and signal transduction.
- To understand the inheritance pattern at molecular level.

❖ **Course Learning Outcome(s):**

- Students will be able to explain the basic concepts of cell biology.
- Students will learn a variety of skills necessary to function as a biologist in the workplace or as a candidate for an advanced degree.

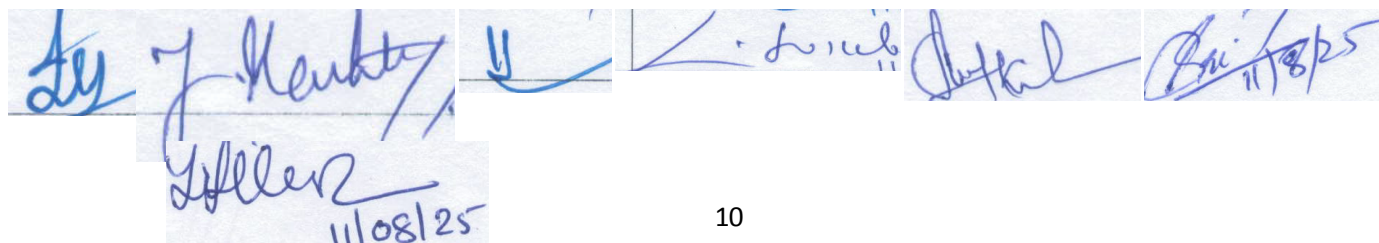
❖ **Course Content**

**UNIT – I: Structure and Functions of Cells**

Discovery of the cell and the cell theory, exceptions to the cell theory. Cell shape, cell size and cell number. Prokaryotic vs eukaryotic cells. Cell motility in prokaryotes and eukaryotes by cilia and flagella. Chemotaxis and Quorum sensing. Cytoskeleton: microtubules, actin filaments and intermediate filaments.

**UNIT – II: Structure and Function of Major Cellular Organelles**

Structure and function of cell wall, plasma membrane, endoplasmic reticulum, Golgi apparatus, lysosomes, peroxisomes, mitochondria and chloroplast. Structure and role of ribosomes.



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### UNIT – III: Nucleus and Chromatin

Structure and function of nuclear membrane. Organization of nuclear material in prokaryotes and eukaryotes. Eukaryotic chromosome – Histone proteins and nucleosomes. Organization of metaphase chromosome in eukaryotes. Chromosome banding pattern, polytene and lamp brush chromosomes. Organization of nucleolus.

By J. K. Kumbhar  
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11/08/25

#### **UNIT – IV: Cell cycle, apoptosis and cancer**

Phases of cell cycle- Regulation of cell cycle: Discovery of MPF, cyclins and cyclin dependent kinases, Check points- role of Rb and p53, Cell division by mitosis and meiosis.

Apoptosis- Neurotrophic factors, caspases, Pathways of apoptosis.

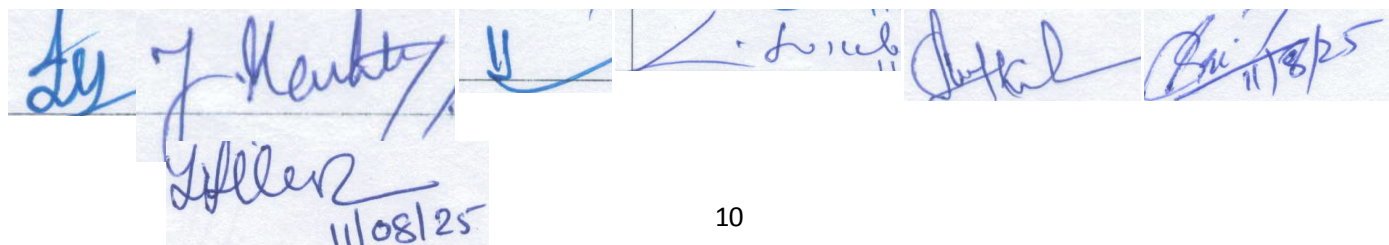
Cancer- Types and stages of cancer, characteristics of cancer cell, carcinogenesis, carcinogens, oncogenes, Tumor suppressor genes and protooncogenes, Molecular basis of cancer, cell senescence.

#### **UNIT – V: Cell –Cell Interactions and Signaling**

Cell to cell interaction – Microvilli, tight junctions, gap junctions, desmosomes. Cell adhesion and cell signaling (autocrine, paracrine, synaptic and endocrine). Second messengers-Types and mechanism of action.

#### **Text books:**

1. Verma P.S and Agarwal V.K. 2006. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand & Company Ltd
2. Lewin B. 2008. Genes IX. Jones and Bartlett publishers
3. Satyanarayana U. 2007. Biotechnology. Books and allied (P) Ltd
4. Darnell J, Lodish H and Baltimore D 1986. Molecular Cell Biology. Scientific American Books.
5. Watson JD, Hopkins NH, Roberts JW et al. 1987. Molecular Biology of the Gene (4th ed.) The Benjamin/Cummings Publishing Company, Inc.
6. Albert's B, Bray D, Lewis J et al. 1989. Molecular Biology of the Cell. Garland publishing Inc.
7. Pasupuleti M. 2006. Molecular Biotechnology. MJP Publishers.
8. Hartl DL and Jones EW. 2000. Genetics – Analysis of Genes and Genomes (5th Ed.) Jonesd and Barlett Publishers.
9. Tamarin RH. 1999. Principles of Genetics (6th Ed.) WCB McGraw-Hill.
10. Karp G. 1998. Cell and Molecular Biology (2nd Ed.) John Wiley and Sons, Inc.
11. Lodish H, Berk A, Matsudaira P et al 2004. Molecular Cell Biology (5th ed.) W.H. Freeman and Company, New York.
12. Becker MW, Kleinsmith LJ and Hardin J. 2007. The world of the Cell (6th Ed.) Tata McGraw Hill Publications.
13. Raven PH, Johnson GB, Losos JB and Singer SR. 2006. Biology (7th Ed.) Tata McGraw Hill Publications.
14. Smith & Wood, Cell Biology, 2nd Edition, Chapman & Hall, London, 1996.



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KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, I SEMESTER**

| Course Name | GENETICS | L | T | P | C | IM | EM | TM  |
|-------------|----------|---|---|---|---|----|----|-----|
| Course Code | 25ZOO102 | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:** This course provides an introductory overview of major and timely topics in genetics. The objective is to provide students with a broadly-based and fundamental understanding of genetics, and to present selected challenges and issues that currently face the genetics research and communities. This course provides students with an understanding of the principles and concepts of genetics and introduces transmission, nature and action of genetic material in organisms

❖ **Course Learning Objectives:**

- Use the principles of chromosome transmission to predict patterns of inheritance.
- Evaluate scientific data using the rules of probability.
- Understand how the structure of DNA enables it to function as genetic material.
- Explain the relationship between genotype and phenotype.
- Understand the molecular basis of mutation, and its role in genetic variation.
- Explain how the genetic code enables protein synthesis to be directed by genetic information.
- Understand how genomes are replicated, repaired, organized and packaged
- Describe the modes of gene regulation in prokaryotes and eukaryotes.
- Use a computer to search public databases and manage bibliographic information.

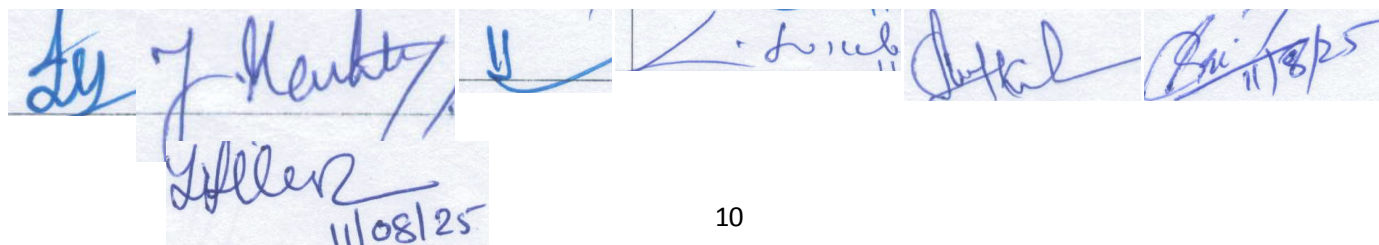
❖ **Course Learning outcomes:**

By completing Genetics course, students are expected to have achieved the following skills and capabilities.

- Comprehensive, detailed understanding of the chemical basis of heredity
- Comprehensive and detailed understanding of genetic methodology and how quantification of heritable traits in families and populations provides insight into cellular and molecular mechanisms.
- Understanding of how genetic concepts affect broad societal issues including health and disease, food and natural resources, environmental sustainability, etc.
- Understanding the role of genetic mechanisms in evolution.
- The knowledge required to design, execute, and analyse the results of genetic experimentation in animal and plant model systems.
- The ability to evaluate conclusions that are based on genetic data.

❖ **Course Content:**

**UNIT – I: Mendelian Laws of Inheritance**



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## UNIT – II: Nature of Genetic Material

Evidence to prove DNA and RNA as genetic material. Gene as a unit of expression. Colinearity of gene and polypeptide. Modern concept of gene. Fine structure analysis of rII locus of T4 bacteriophage – Establishment of recon, muton and cistron. Complementation test. Types of genes – Pseudogenes, House-keeping genes, homeotic genes and regulatory genes.

## UNIT – III: Plasmids and Transposons

Plasmids: Types, copy number, replication, amplification and curing. Regulation of col E1 plasmid replication. Methods of plasmid transfer – Microinjection, electroporation, calcium chloride treatment, triparental mating.

Transposons: Types of bacterial transposons - insertional sequences, complex transposons. Retroposons. Transposons of eukaryotes – Copia, P3 and TY elements. Mechanism of transposition – Replicative and non-replicative.

## UNIT – IV: Genetic Recombination in Bacteria

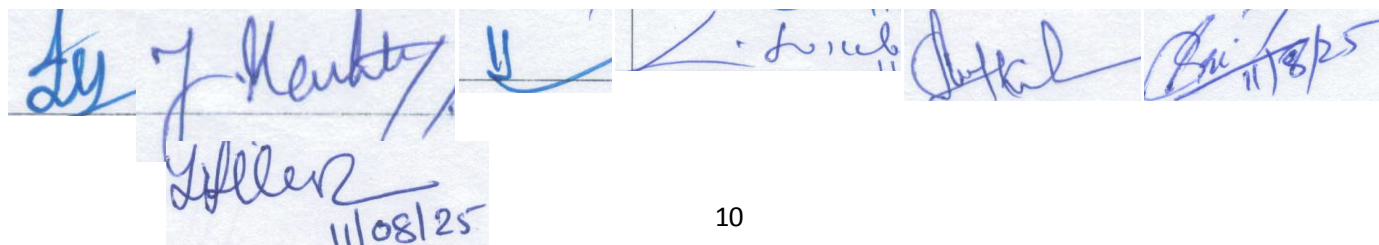
Genetic recombination in bacteria. Models of genetic recombination (Break-join, Copy-choice, Break-copy). Role of recA protein. Genetic transfers in bacteria. Discovery and mechanism of transformation. Discovery and mechanism of Transduction (generalized, specialized and abortive). Discovery of sex among bacteria. Genetic transfer by Conjugation ( $F^+$  and  $F^-$ ,  $F'$  and  $F^-$  (sexduction), and Hfr and  $F^-$ ). Mapping of bacterial chromosome by genetic recombination, transformation, conjugation and transduction.

## UNIT – V: Mutations and Mutagenesis

Mutations and mutagenesis: Types of mutations, Mutagenic agents, Molecular basis of mutations, Mechanism of Mutagenesis. Transposon mutagenesis, Site-directed mutagenesis and their applications. Evaluation of mutagens by Ames test and micro nuclei test. Thymine dimerization. Repair of T-dimers: Photo-reactivation, Excision repair, Post-replication, Recombination and SOS repair mechanisms. Heat-shock and adaptive responses, role of recA in DNA repair.

### ➤ Text books:

1. Cell Biology : DeRobertis and DeRobertis
2. Molecular biology of cell: B.Alberts et al Cell
3. Molecular biology: G.Karp
4. Molecular Biology of the cell: J.D.Watson et al
5. Genes VII: B.Lewin
6. Lehninger's Principles of Biochemistry: Nelson and Cox. Biochemistry: L.Stryer
7. Biochemistry: Voet and Voet.



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KRISHNA UNIVERSITY: : MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, I SEMESTER**

| Course Name | BIOMOLECULES | L | T | P | C | IM | EM | TM  |
|-------------|--------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOO 103    | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

- ❖ **Course description & Purpose:** In this course you will learn about molecules of life. Biomolecules are important for the functioning of living organisms. These are building blocks of living organisms, so the presence of appropriate concentration of biomolecules are important for structure and proper function of living cells. Macro biomolecules are built from small organic compounds the same way a railroad train is built. By linking a lot of smaller units together into long chain. The course encompasses the structure, monomer, examples, functions, bonds of biomolecules. The overall goal of this course is to give students knowledge of biomolecules.
- ❖ **Course Learning Objectives:**
  - To provide details about the importance of the Biomolecules present in our system and the regulation of metabolic pathways.
  - To expose the students to the biochemical methods used to study the biomolecules.
- ❖ **Course Learning Outcomes:**
  - Students will be able to demonstrate an understanding of fundamental biochemical principles, such as the structure and functions of Biomolecules structures and the functions of biological/biochemical processes.
  - They will gain proficiency in basic laboratory techniques in both chemistry and biology, and be able to apply the scientific method to the processes of experimentation and hypothesis testing.
  -
- ❖ **Course Content:**

#### **UNIT – I : Carbohydrates**

Definition and Classification of carbohydrates, reactions of monosaccharides, acid Derivatives of monosaccharides, Amino sugars, disaccharides, oligo saccharides, mucopolysaccharides, polysaccharides, starch, cellulose, lectins, glycoproteins.

#### **UNIT – II: Amino acids**

Classification, structure and physico-chemical properties of amino acids, stereoisomerism, chemical reactions of amino acids and chemical procedures affecting amino acid side chains.

Peptides: Structure and confirmation of peptide bond; Peptide synthesis - reactive ester method and modified merrifield solid phase peptide synthesis. Non-ribosomal peptide synthesis - glutathione cyclic antibiotics (gramicidin). Identification of peptide sequence- protease treatment, site directed mutagenesis.

### **UNIT – III : Proteins**

Classification and biological functions of proteins (Eg: RuBisCo, LegHemoglobin). Structural organization of proteins – primary, secondary, tertiary and quaternary structure of proteins. Protein folding and significance. Ramachandran plot.

### **UNIT – IV : Fatty acids & Lipids**

Classification, physical and chemical properties of fatty acids. Characterization of natural fats, oils. Structure and biological role of triacyl glycerol, phospholipids, sphingolipids, prostaglandins, thromboxanes, leukotrienes, and steroids. Lipids as signaling molecules. Porphyrins- Structure and functions of porphyrins, protoporphyrin, cytochrome, heme, chlorophyll.

### **UNIT-V: Nucleic acids**

Structure of purines and pyrimidines, modified bases. Structure of DNA (Primary, Secondary and Tertiary). Structure of RNA- mRNA, tRNA, rRNA (Primary, Secondary and Tertiary) Physico-chemical properties of nucleic acids, denaturation, hyper chromic effect, T<sub>m</sub>, kinetics of reassociation, cot values.

#### ➤ Text books:

1. Textbook of Biochemistry. West and Todd. 1968. MacMillan.
2. Principles of Biochemistry. A. L. Lehninger. 1993. Nelson and Cox. C. B.S., India.
3. Principles of Biochemistry General Aspects. Smith et al, 1983. McGraw hill
4. Biochemistry Donald Voet and Judith Voet. 2nd Edn.
5. Biochemistry. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer 2002. 5th Edn. Freeman
6. Textbook of Biochemistry with Clinical Correlation. Thomas M. Devlin. 4th Edn
7. Biochemistry. Zubay
8. Nucleic acid Biochemistry and Molecular Biology by Main Waring et al, Blackwell.
9. Biochemistry, 2nd Edn. by Albert L. Lehninger. 1978. Kalyani Publishers, New Delhi
10. Biochemical calculations, Irwin H. Segel, John Wiley and sons Inc.
11. Biochemistry, Reginald A. Garret, Charles M. Grisham. 1995. National Academy of Sciences, USA. 2<sup>nd</sup> Edn.
12. Organic Chemistry, DJ. Cram and GS Hammon.
13. Biochemistry. Mathews
14. Biochemistry. B.D. Hames, N.M. Hooper
15. Practical Biochemistry. Wilson and Walker.

KRISHNA UNIVERSITY: : MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, I SEMESTER**

| Course Name | SYSTEMATICS OF INVERTEBRATES | L | T | P | C | IM | EM | TM  |
|-------------|------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOO104                    | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:**

This course provides the basic information on the fundamental criteria for classification of animal and basic knowledge about method of sample collection and preservation for taxonomic studies. This course highlights the classification of invertebrates in detail.

❖ **Course Learning Objectives:**

To make students to understand

- The scientific approaches of taxonomy.
- Basic criteria for animal classification. Code of biological nomenclature Classification of invertebrates

❖ **Course Learning Outcomes:**

Student will gain knowledge on the

- Logical approaches in taxonomy
- important criteria for the classification of animals,
- Importance of code of biological nomenclature
- an overview on invertebrate classification.

❖ **Course Content**

**Unit-I Concept of Systematics**

Definition and basic concepts of biosystematics and taxonomy, Histological resume of Systematics hierarchy of categories, Taxonomic characters – different kinds.

Dimensions of speciation and taxonomy characters, Dimensions of speciation- types of lineage changes, production of additional lineage, Mechanisms of speciation in panmictic and apomictic species, Species concepts – species category, different species concepts: sub-species and other infra specific categories, biological mechanism of genetic incompatibility.

**Unit-II Taxonomic Procedures**

Procedure keys in taxonomy, Taxonomic procedures – taxonomic collections, preservation, curation process of identification.

Trends in biosystematics – concepts of different conventional and newer aspects, Chemotaxonomy- Cytotaxonomy- Molecular taxonomy, classification based on acoelome, pseudocoelome, eucoelome, nutrition and feeding.

**Unit-III Zoological Nomenclature**

Process of typification and different Zoological types, International Code of Zoological Nomenclature (ICZN) – its operative principles, Zoological nomenclature, Formation of scientific names of various taxa.

#### **Unit-IV Invertebrate Phyla-1**

General characters and Systematics of Phylum-Protozoa, Porifera, Coelenterata, Platyhelminthes, Nematoda and Annelida

#### **Unit-V Invertebrate Phyla-2**

General characters and Systematics of Phylum-Arthropoda, Mollusca, Echinodermata, Connecting links among Invertebrates and their significance.

➤ **Text books :**

1. EL.Jordan, PS. Verma, Invertebrate Zoology, S.Chand Publishers
2. R.L. Kotpal. Modern text book of zoology invertebrates .
3. Veer Balarastogi, Invertebrate zoology

➤ **Reference books:**

1. M. Kato. The Biology of Biodiversity, Springer.
2. J.C. Avise. Molecular Markers. Natural History and Evolution, Chapman & Hall, New York.
3. E.O. Wilson. Biodiversity, Academic Press, Washington.
4. G.G. Simpson. Principle of Animal Taxonomy. Oxford IBH Pub.Co.
5. E. Mayer. Elements of Taxonomy.
6. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
7. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.
8. International code of zoological Nomenclature, third edition.

KRISHNA UNIVERSITY: : MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, I SEMESTER**

| Course Name | PERSONALITY DEVELOPMENT<br>THROUGH LIFE<br>ENLIGHTENMENT SKILLS | L | T | P | C | IM | EM | TM  |
|-------------|-----------------------------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOO105                                                       | 3 | 0 | 1 | 3 | 30 | 70 | 100 |

❖ L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description:**

Personality development is the development of your behavior patterns and attitude. It is the result of where we are born, the circle we interact with and our personal temperament. Every person is different. There are some characteristics traits that make you „you“. Personality development through life enlightenment course aims to help students identify negative behaviors which may be stopping them from reaching their desired goals. This course will help students both in their personal and desired professional life. The other purposes of personality development through life enlightenment course are to enable you lead stress-free and healthier life, ethical decision-making ability, enhanced confidence level, and building a more pleasing personality.

❖ **Course Objectives:**

The course aims to cause a basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality

Specific objectives include:

- Learn to achieve the highest goal happily.
- Become a person with stable mind, pleasing personality and determination.
- Learn to build positive attitude, self-motivation, enhancing self-esteem and emotional intelligence
- Learn to develop coping mechanism to manage stress through Yoga and meditation techniques
- Awaken wisdom among them.

❖ **Course Learning Outcomes:**

At the end of this course the students should be able to:

- Develop their personality and achieve their highest goals of life.
- Lead the nation and mankind to peace and prosperity
- Develop a versatile personality
- Practice emotional self-regulation.
- Develop a positive approach to work and duties
- Develop a versatile personality

❖ **Course Content**

**UNIT- I: Introduction to Personality Development**

The concept of personality - Dimensions of Personality – Theories of Personality development(Freud & Erickson)  
– The concept of Success and Failure – Factors responsible for Success –Hurdles in achieving Success and Overcoming Hurdles — Causes of failure – Conducting SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis.

## **UNIT- II: Attitude, Motivation and Self-esteem**

Conceptual overview of Attitude – Types of Attitudes – Attitude Formation – Advantages/ Disadvantages of Positive/Negative Attitude - Ways to Develop Positive Attitude.

**Concept of motivation:** Definition and Nature of Motivation/Motive – Internal and external motives – Theories of Motivation – Importance of self- motivation- Factors leading to de- motivation.

**Self-esteem** - Definition and Nature of self-esteem – Do's and Don'ts to develop positive self-esteem – Low self-esteem – Personality having low self-esteem - Positive and negative self-esteem.

## **UNIT -III: Other Aspects of Personality Development**

Body language - Problem-solving - Conflict Management and Negotiation skills - Decision-making skills - Leadership and qualities of a successful leader – Character building -Team-work – Time management - Work ethics – Good manners and etiquette – Emotional Ability/Intelligence – Dimensions of Emotional Intelligence – Building Emotional Intelligence.

## **UNIT- IV: Neetisatakam-Holistic Development of Personality**

Verses- 19,20,21,22 (wisdom) – Verses- 29,31,32 (pride and heroism) – Verses- 26,28,63,65(virtue)

### **Personality of Role Model – Shrimad Bhagwadgeeta**

Chapter 2-Verses 17, Chapter 3-Verses 36,37,42 – Chapter 4-Verses 18, 38,39 Chapter 18-Verses 37,38,63

## **UNIT -V: Yoga & Stress Management**

Meaning and definition of Yoga - Historical Perspective of Yoga - Principles of Astanga Yoga by Patanjali – Meaning and Definition of Stress - Types of Stress - Eustress and Distress – Stress Management – Pranayama- Pranayama: Anulom and Vilom Pranayama - Nadishudhi Pranayama– Kapalabhati-Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama – Meditation techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT) (Theory & Practical).

## **PRACTICAL COMPONENTS:**

- Students should identify different types of personality to know their own personality. Students are to describe the characteristics of their personalities and submit the same for assessment.
- Students are to form in groups (a group consists of 4-6 students) to identify and write a brief note on famous personalities of India and World.
- Students are required to identify different types of attitudes and give any five examples of each.
- Students are expected to check their attitudes and develop ways to improve their attitudes at work place and home.
- Students are required to identify keys to self-motivation to achieve their goals.

Students are expected to identify at least seven types of body language and conduct activities with the following:

| S. No. | Pose                                  | Possible Interpretations |
|--------|---------------------------------------|--------------------------|
| 1      | Standing with your hands on your hips | Aggressive, disgusted    |
| 2      | Standing upright                      | Confidence               |
| 3      | Arms crossed on your chest            | Defensive                |
| 4      | Resting your hand on your cheek       | Thinking                 |
| 5      | Touching or rubbing your nose         | Doubt, lying             |
| 6      | Resting your head in your hands       | Boredom, tired           |
| 7      | Tapping your fingers                  | Impatience               |
| 8      | Biting your nails                     | Nervous, insecure        |
| 9      | Playing with your hair                | Insecure                 |
| 10     | Rubbing your eyes                     | Disbelief, doubt         |

### **Conduct the following exercise to develop communication skills –Negotiation Skills and Empathy**

#### **Exercise: Card Pieces**

In this activity, team members trade pieces of playing cards to put together complete cards.

**Uses-**This exercise is useful for showing team members others' perspectives. It builds communication and negotiation skills, and helps people to develop empathy.

#### **People and Materials**

- Enough people for at least three teams of two.
- Playing cards – use between four and six for each person.
- A private room.

#### **Time -15 minutes. Instructions:**

1. Cut each playing card into half diagonally, then in half diagonally again, so you have four triangular pieces for each card.
2. Mix all the pieces together and put equal numbers of cards into as many envelopes as you have teams.
3. Divide people up into teams of three or four. You need at least three teams. If you're short of people, teams of two will work just as well.
4. Give each team an envelope of playing card pieces.
5. Each team has three minutes to sort its pieces, determine which ones it needs to make complete cards, and develop a bargaining strategy.
6. After three minutes, allow the teams to start bartering for pieces. People can barter on their own or collectively with their team. Give the teams eight minutes to barter.
7. When the time is up, count each team's completed cards. Whichever team has the most cards wins the round.

#### **Advice for the Teacher/Facilitator**

After the activity, ask your team members to think about the strategies they used. Discuss these questions

- 1) Which negotiation strategies worked? Which didn't?
- 2) What could they have done better?
- 3) What other skills, such as **active listening** or **empathy**, did they need to use?

## **Conduct following Time management activity - Ribbon of Life**

Take a colored ribbon length of approximately 1 meter/100 cm. and scissors. Start with the following questions:

1. If the life span of an individual is say, 100 years. Consider that each cm represents one year. The response will be that few live that long. Assuming a life of 75 to 90 years, cut 10 to 25 cm off the ribbon, accordingly.
2. What is the average age of the participants sitting here, the response would be 25 to 30 depending on the group, in that case, cut another 25 cms of the ribbon and say that is gone you cannot do anything.
3. What is left is 50 years? People will say, "Yes," but the answer is NO.
4. Every year we have 52 weeks, that is 52 Sundays. If we multiply that by 50 years, it comes to 7.14 years. Reduce the ribbon by another 7.14 cm.
5. We also usually have Saturdays off, so reduce another 7. cms.
6. Public/National holidays are 10 multiple with 50 years. That comes to another 1.5 years. Reduce ribbon by another 1.5 cms.
7. Your casual leave, sick leave, and annual holidays approx. 40 days a year, multiplied by 50. Cut off another 5 cms. Now you are left with about 29.5 years. But, the calculation is not over yet.
8. You sleep an average of 8 hours daily; multiply that by 365 days and again by 50 years ( i.e.  $122 \text{ days} \times 50 = \text{almost } 17 \text{ years}$ ). Cut off another 17 cm.
9. You spend time eating lunch, breakfast, snacks, and dinner total 2 hours daily (i.e.  $30 \text{ days a year} \times 50 \text{ years} = 4 \text{ years or so}$ ). Cut off another 4 cm.
10. Last, let's figure we spend about 1 hour a day traveling from place to place for activities and such. (that's about 2 more years). We're down to 6 (SIX) years of life to make it or break it.

### **• Exercise Decision making skills - Create Your Own**

In this exercise, teams must create their own, brand new, problem-solving activity.

**Uses:** This game encourages participants to think about the problem-solving process. It builds skills such as creativity, negotiation and decision making, as well as communication and time management. After the activity, teams should be better equipped to work together, and to think on their feet.

### **What You'll Need**

- Ideally four or five people in each team.
- A large, private room.
- Paper, pens and flip charts.

**Time -Around one hour.**

### **Instructions:**

1. As the participants arrive, you announce that, rather than spending an hour on a problem-solving team building activity, they must design an original one of their own.
2. Divide participants into teams and tell them that they have to create a new problem-solving team building activity that will work well in their organization. The activity must not be one that they have already participated in or heard of.
3. After an hour, each team must present their new activity to everyone else, and outline its key benefits.

### **Advice for the Teacher/Facilitator:**

There are four basic steps in problem solving : defining the problem, generating solutions, evaluating and selecting solutions, and implementing solutions. Help your team to think creatively at each stage by getting them to consider a wide range of options. If ideas run dry, introduce an alternative brainstorming technique, such as brain writing . This allows your people to develop one others' ideas, while everyone has an equal chance to contribute.

After the presentations, encourage teams to discuss the different decision-making processes they followed. You might ask them how they communicated and managed their time. Another question could be about how they kept their discussion focused. And to round up, you might ask them whether they would have changed their approach after hearing the other teams' presentations.

- Students are asked to recite verses: 26,28,63,65 (virtue) of Neetisatakam-Holistic development of personality.
- Students are asked to identify personality of role models from Shrimad Bhagwadgita and portray the roles of the same.
- Students are asked to practice Yoga and meditation techniques

#### **Text and Reference Books:**

1. Hurlock, E.B. Personality Development, 28th Reprint. New Delhi: Tata McGraw Hill, 2006.
2. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar- vairagya, New Delhi, 2010
3. Swami Swarupananda, Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.
4. Lucas, Stephen. Art of Public Speaking. New Delhi. Tata - Mc-Graw Hill. 2001
5. Mile, D.J Power of positive thinking. Delhi. Rohan Book Company, (2004).
6. Pravesh Kumar. All about Self- Motivation. New Delhi. Goodwill Publishing House. 2005.
7. Smith, B. Body Language. Delhi: Rohan Book Company. 2004
8. Yogic Asanas for Group Training - Part-I: Janardhan Swami Yogabhyasi Mandal, Nagpur.
9. Rajayoga or Conquering the Internal Nature by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata.
10. Nagendra H.R and Nagaratna R, Yoga Perspective in Stress Management, Bangalore, Swami Vivekananda Yoga Prakashan.

#### **Online Resources:**

1. [https://onlinecourses.nptel.ac.in/noc16\\_ge04/preview](https://onlinecourses.nptel.ac.in/noc16_ge04/preview)
2. <https://freevideolectures.com/course/3539/indian-philosophy/11>

KRISHNA UNIVERSITY: : MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY

**M.Sc. – ZOOLOGY , I SEMESTER**

| <b>Course Name</b> | <b>CELL BIOLOGY &amp; GENETICS</b> | <b>L</b> | <b>T</b> | <b>P</b> | <b>C</b> | <b>IM</b> | <b>EM</b> | <b>TM</b>  |
|--------------------|------------------------------------|----------|----------|----------|----------|-----------|-----------|------------|
| <b>Course Code</b> | <b>25 ZOOL101</b>                  | <b>0</b> | <b>0</b> | <b>6</b> | <b>3</b> | <b>30</b> | <b>70</b> | <b>100</b> |

**L**-Lecture, **T**-Tutorial, **P**-Practical, **C**-Credits, **IM**-Internal Marks, **EM**-External Marks, **TM**-Total Marks

➤ **List of experiments**

➤ **Cell biology**

1. Light microscopic examination of various plant tissues
2. Determination of cell size (ocular micrometer)
3. Stages of mitosis and meiosis
4. Squash preparation.
5. Sub-cellular fractionation- separation of macromolecules
6. Study of polytene chromosomes.
7. Karyotypic study.

➤ **Genetics**

1. Demonstration of chromosomal (structural and numerical) aberrations.
2. Effect of colchicine on chromosomes.
3. Demonstration of Mendelian laws using colour marbles or beads.
4. Evaluation of segregation and random assortment using Chi square test or test of fitness.
5. Construction of genetic maps based on problems in two and three factor crosses.

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, I SEMESTER**

| Course Name | BIOMOLECULES AND<br>SYSTEMATICS OF<br>INVERTEBRATES | L | T | P | C | IM | EM | TM  |
|-------------|-----------------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOOL102                                          | 0 | 0 | 6 | 3 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

➤ **List of experiments**

➤ **Biomolecules**

1. Titration of Amino acids
2. Calorimetric determination of Pka
3. Model building using space, filling/ ball and stick models
4. Reactions of amino acids, sugars and lipids, including diagnostic tests
5. Isolation, purity determination and quantization of cholesterol DNA ad RNA
6. Quantization of proteins and sugars
7. Analysis of oils-iodine number, saponification value and acid number

➤ **Systematics of invertebrates**

1. Specimens and spotters of invertebrates in the order of evolution
2. A practical approach towards Biosystematics and taxonomy
3. Molecular perspective of diversity –Identification of species by molecular separation of proteins by examples.
4. Methods of collection, preservation and identification of plankton and representative forms of terrestrial and aquatic fauna.

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course name | BIOANALYTICAL TECHNIQUES | L | T | P | C | IM | EM | TM  |
|-------------|--------------------------|---|---|---|---|----|----|-----|
| Course code | 25 ZOO201                | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course description and Purpose**

This course is introduced to bridge the gap between academics, research and industry. This course begins with a review of basic bio analytical technique and an introduction to general terminologies. This course contains bio analytical techniques along with their theory, working principal, common instrumentation and possible applications. This course will be equally beneficial to various scientific areas including, life science, chemical science, material science and environmental science.

❖ **Course Learning Objectives:**

- To understand about the canonical structure of bio-instrumentation systems.
- To learn the qualitative functions of the primary system components.
- To learn the technical information's associated with instrumentation and design and basic signal analysis.

❖ **Course Learning Outcomes:**

- Describes and explains the principles of various bio-instrumental devices and sensors.
- Demonstrate an ability to use appropriately and safely the techniques, sensors, and selected - modern engineering tools necessary for bio-instrumentation practice.

❖ **Course Content:**

**UNIT – I :Study of Solvents & Centrifugation**

Measurement of pH, pH meter, biochemical buffers & non-aqueous solvents. Classification of colloids and their properties. Basic principles of centrifugation, types of centrifuges and rotors. Preparative ultracentrifugation-differential centrifugation, density-gradient. Analytical ultracentrifugation and applications.

**UNIT – II: Chromatography**

General principles of Chromatography. Methods based on polarity - partition chromatography (paper chromatography). Adsorption chromatography (thin- layer chromatography). Gas-liquid chromatography, reverse phase liquid chromatography. Methods based on size- Gel filtration chromatography.

Methods based on affinity: Affinity chromatography. High performance liquid chromatography and Ion- exchange chromatography.

**UNIT – III: Electrophoresis**

General principles of Electrophoresis and Factors affecting electrophoretic mobility. Types, methodology and applications of Electrophoresis. PAGE (Native – PAGE, SDS-PAGE). 2-dimensional electrophoresis Agarose gel electrophoresis (denaturing Agarose Gel Electrophoresis, recovery of DNA from gel). Pulse field gel electrophoresis.

#### **UNIT – IV: Spectrophotometry**

Basic principles – law of absorption (Beer – Lambert law).UV-visible spectrophotometry.Infrared spectroscopy, Fluorescence Spectroscopy, Atomic absorption spectrophotometry Mass spectrophotometry and NMR spectrophotometry.

Basic principles and application of X- ray diffraction and X- ray crystallography.

#### **UNIT – V: Radioactivity**

Nature and types of radioactivity, radioactive decay. Preparation of labeled biological compounds. Detection and measurement of radioactivity (GM counter, scintillation counter, Cerenkov radiation, autoradiography, gamma-ray counter).

Production, biological uses and safety measures in handling of radioisotopes.



#### **Text books:**

1. Nuclear Magnetic Resonance: William
2. Biochemical Techniques theory and practice: White R
3. Analytical Chemistry: Christion G. D.
4. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
5. An Introduction to Practical Biochemistry: Plummer D. T.

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | SYSTEMATICS OF VERTEBRATES & WILDLIFE CONSERVATION | L | T | P | C | IM | EM | TM  |
|-------------|----------------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOO202                                          | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:**

This course provides detailed knowledge of protochordates their classification and their importance in the evolution of higher chordates, and the classification of vertebrates in detail and also focus in the importance of wild life and its conservation methods and strategies.

❖ **Course Learning Objectives:**

- To make students to understand- The systematics of chordates
- Primitive features of Protochordates Diversity of chordates
- Biodiversity distribution and importance Conservation methods of biodiversity.

❖ **Course Learning Outcomes:**

- Student will gain knowledge on the detailed taxonomic features of protochordates diversity of Vertebrates and their classification a clear idea on biodiversity distribution and its uses
- Conservation method on national and International

❖ **Course Content**

**Unit-I :** General characters of phylum Chordatas, Protochordates in general: Hemichordata, Urochordata, Cephalochordata – comparison and special characters.  
General characters of fishes and its classification

**Unit – II :** Amphibia: General characters and classification

Reptiles: General characters and classification poisonous and non-poisonous snakes

Aves: General characters and classification Mammalia: General characters and classification

**Unit – III :** Biodiversity, magnitude, global accumulation; levels biodiversity- species, Hot spots in India, genetic and ecosystem diversity; species diversity indices, rank abundance patterns  
Biodiversity uses and ecosystem services; threats to biodiversity- habitat loss, habitat fragmentation, exotic species and environmental pollution; species extinction;

**Unit – IV:** Importance of conservation biology, Management of aquatic living resources, Marine living resources, Freshwater resources. IUCN threat categories- global and national status; Threats to aquatic and marine biodiversity. Endangered and threatened species of India; Biodiversity assessment and monitoring.

**Unit – V:** In situ Biodiversity & Wildlife conservation strategies and approaches: Protected areas, biosphere resource, protected areas in India – Sanctuaries, national parks and biosphere resources.  
Ex Situ Biodiversity conservation: Species management plans, captive breeding, field gene banks, seed gene banks, cryopreservation, in vitro conservation. National and international efforts for biodiversity conservation- CITES, Ramsar Convention, Convention on biological diversity CBD.

➤ **Text books:**

1. SN.Prasad, V.Kashyap, A Text Book of Vertebrate Zoology, New Age International Publishers
2. R.L. Kotpal, Modern text book of Zoology Vertebrates,

➤ **Reference books:**

1. T.J. Parker and W.A. Haswell. Text book of Zoology, Vol.2
2. Vertebrates (Eds.), A.J. Marshall, ELPS and MacMillan, 1972.
3. R. L. Kotpal, Modern text book of zoology vertebrates.
4. J.z. Young, The life of vertebrates.
5. J.Z. Young, The life of Mammals, Clarendon press, 1966
6. G. Arnold, Kluge and Elaal. Chordate structure and Function, Macmillan Publishing Co., Inc, New York, London, 1977.
7. Chandel, K.P.S., Shukla, G. And Sharma, N. (1996) Biodiversity in Medicinal and Aromatic Plants in India Conservation and Utilization, National Bureau of Plant Genetic Resources, New Delhi.
8. Heywood, V. (Ed.) (1995). Global Biodiversity Assessment. United Nations Environment Programme, Cambridge University Press, Cambridge, U.K.
9. Hunter (Jr.) M.L. (1996). Fundamentals of Conservation Biology, Blackwell Science.
10. Huston, M.A. (1994). Biological Diversity: The Coexistence of Species on Changing Landscapes. Cambridge University Press, Cambridge.
11. Meffe G.K. and C. RonalsCorroll (1994) Principles of Conservation Biology, Sinaur Associates, Inc., Sunderland. Massachusetts.
12. Rodgers, N.A. and Panwar, H.S. (1998). Planning A Wildlife Protected Area Network in India. Vol. 1. The Report Wildlife Institute of India. Dehradun.
13. Soule, M.E. (ed.) (1986): Conservation Biology. The Science of Scarcity and Diversity. Sinaur Associates, Inc., Sunderland, Massachusetts.

KRISHNA UNIVERSITY :: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | ANATOMY OF<br>INVERTEBRATES &<br>VERTEBRATES | L | T | P | C | IM | EM | TM  |
|-------------|----------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOO203                                    | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:**

This course provides detailed knowledge of anatomy of animal i.e. coelom organization, integument and its derivatives, circulatory system evolution, Heart comparative study, development and comparative study of brain among vertebrates, and receptors types their structural organization.

❖ **Course Learning Objectives:**

- To make students to understand - The detailed organization of coelom, its types, and importance
  - Structural organization in the larval forms and their significance.
  - Feature of minor Phyla. Integument and its derivatives.
- Structural organization of circulatory system, nervous system, excretory system, and mammalian eye structure, and lateral lines system, etc.

❖ **Course Learning Outcomes:**

- Student will gain knowledge on the
- Detailed organization of coelom, larval forms their significance in evolution, integument modification among animals, circulatory, nervous, excretory systems, structure and functioning of mammal eye, and various receptors.

❖ **Course Content**

**Unit-I:** Nature of Morphology, Scope and relation to other disciplines.

Origin of coelom - Acoelomates, Pseudocoelomates, Coelomates- Protostomia and Deuterostomia.  
Excretion - Organs of excretions: Coelom, Coelomoducts, Nephridia and Malpighian tubules  
Mechanism of excretion.

**Unit-II:** Invertebrate larvae. Larval forms of free living invertebrates, Annelida, Arthropoda, Mollusca and Echinodermata – structural organization and salient features, Strategies and evolutionary significance of larval forms.

Minor Phyla-Concepts and Significance, Organization and general characters-Rotifera, Chetognatha.

**Unit-III:** Vertebrate integument and its derivatives. Development, general structure and function of skin and its derivatives – glands, scales, horns, claws, nails, hooves, feathers and hair.  
General plan of circulation in various groups –Evolution of heart, evolution of aortic arches and portal systems.

**Unit-IV:** Nervous system and Urinogenital system. Evolution of urino-genital system in vertebrates. Comparative anatomy of the brain in relation to its functions.  
Nerves-cranial, peripheral and autonomous nervous system.

**Unit-V:** Electric organs & Receptors. Simple receptors-types of receptors, primary and secondary receptors. Chemoreceptions- Organs of Olfaction and taste. Photoreception in mammal and defects in vision.

Lateral line system and lateral line organs of fish – Neuromast organs Electric organs and Electroreception – Ampullary and Tuberous reception.

➤ **Text books :**

1. Kenneth V. Kardong, Edward J. Zalisko, Comparative Vertebrate anatomy
2. EL.Jordan, PS. Verma, Invertebrate Zoology, S.Chand Publishers
3. R.L. Kotpal. Modern text book of zoology invertebrates .
4. Veer Balarastogi, Invertebrate zoology
5. SN.Prasad, V.Kashyap, A Text Book of Vertebrate Zoology, New Age International Publishers
6. R.L. Kotpal, Modern text book of Zoology Vertebrates,

➤ **Reference books:**

1. Hyman, L.H. The Invertebrates, Vol.1, Protozoa through Ctenophora, McGraw Hill Co., New York.
2. Barrington, E.J.W. Invertebrate structure and function, Thomas Nelson and Sons Ltd., London.
3. Hyman, L.H. The Invertebrates, Vol.2, McGraw Hill Co., New York.
4. Hyman, L.H. The Invertebrates, Vol.8, McGraw Hill Co., New York and London.
5. Barnes, R.D. Invertebrates Zoology, III edition, W.B. Saunders Co., Philadelphia.
6. Hyman, L.H. The Invertebrates: Smaller coelomate groups, Vol. V, McGraw Hill Co., New York.
7. T.J. Parker and W.A. Haswell. Text book of Zoology, Vol.2
8. Vertebrates (Eds.), A.J. Marshall, ELPS and MacMillan, 1972.
9. R. L. Kotpal, Modern text book of zoology vertebrates.
10. J.Z. Young, The life of vertebrates.
11. J.Z. Young, The life of Mammals, Clarendon press, 1966
12. G. Arnold, Kluge and Elaal. Chordate structure and Function, Macmillan Publishing Co., Inc, New York, London, 1977.

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS (IPR) | L | T | P | C | IM | EM | TM  |
|-------------|-----------------------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOO 204                                                | 3 | 0 | 1 | 3 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description:**

Research Methodology& IPR (PHYC204) course is aimed to develop research bent of mind (spirit of inquiry) and impart research skills to the all Post graduate students. It also encompasses the series of research methodology contents: from problem formulation, to design, to data collection, analysis, reporting and dissemination. This course also covers intellectual property rights (IPR), and intended to equip students with conceptual understandings of current scenario of IPR, and the practical issues encountered in filing patents, trademarks and copyrights.

❖ **Course Learning Objectives:**

The objective of research is to find answers to the questions by applying scientific procedures. In other words, the main aim of research is to find out the truth which is hidden and has not yet been discovered

Specific objectives include:

- ✓ To understand some basic concepts of research and its methodologies
- ✓ To develop an understanding of the basic framework of research process.
- ✓ To develop an understanding of various research designs and techniques.
- ✓ To identify various sources of information for literature review and data collection.
- ✓ Ability to write a research Proposal, report and thesis
- ✓ To demonstrate knowledge and understanding of IPR Filing and Rights

❖ **Course Learning Outcomes:**

At the end of this course the students should be able to:

- Understand some basic concepts of research and its methodologies
- Identify appropriate research topics
- Select and define appropriate research problem and parameters
- Demonstrate the ability to choose methods appropriate to research aims and objectives
- Have adequate knowledge on measurement & scaling techniques
- Have basic awareness of data analysis-and hypothesis testing procedures
- Prepare a project proposal (to undertake a project)
- Write a research report and thesis
- File Patents, Trademarks and Copy Rights

❖ **Course Content:**

**UNIT- I: Foundations of Research & Research Design**

Meaning of Research – Definitions of Research – Motivation in Research – General Characteristics of Research – Criteria of Good Research – Types of Research – Research Process – Research Methods vs. Methodology – Defining and Formulating the Research Problem – Review of Literature – Approaches to Critical Literature Review – Importance of Literature Review in Identifying Research Gaps and Defining a Problem – Development of Working Hypothesis.

**UNIT- II: Research Design, Sampling Concepts, and Data Collection Methods**

Meaning, Significance and Characteristics of Good Research Design–Types of Research Design: Exploratory, Conclusive Research and Experimental – Sampling Theory: Types of Sampling and Errors in Sampling – Data Collection: Types of Data – Data Collection Methods and Techniques for Primary and Secondary Data.

### **UNIT-III: Measurement & Scaling Techniques, Hypothesis Formulation and Testing, Overview of Data Analysis and Report Writing**

Basic measurement scales –Reliability & Validity – Definition and Types of Hypothesis– Hypothesis Formulation and Testing Procedure – Overview of Data Analysis: Methods, Process and Types–Report Writing: Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report Precautions for Writing Research Reports – How to Write a Research Proposal– Research Ethics, Conflict of Interest and Plagiarism.

### **UNIT- IV: Intellectual Property Rights (IPR)**

Definition and Nature and Features of Intellectual Property Rights (IPR) –Types of IntellectualProperty Rights – Procedure for Grants of Patents –Rights of a Patent – Scope of a Patent Rights-Licensing and Transfer of Technology–Why protection of intellectual property is important? Enforcement of IPR – Infringement of IPR

### **UNIT -V: Indian and International Scenario and New Developments in IPR**

IPR Developments in India for the past Five Years – Development of IPR Laws in India – International Cooperation on IPR – New Developments in IPR – Administration of Patent System –International Patent protection – Case Studies in Indian and Global Contexts.

### **PRACTICAL COMPONENTS:**

1. Students should identify different research problems with examples and describe the characteristics of researchable problems in their academic area/society/community/organization concerned.
  2. Students are to form in groups (a group consists of 4-6 students) and conduct critical literature survey with regard to the identified research problems and prepare a brief literature review coupled with research gaps and working hypothesis.
  3. Students are required to identify and develop good research design to address the definedresearch problems.
  4. Students are expected to write the research design on Exploratory and DescriptiveResearch.
  5. Students are required to develop practical experience in writing a research proposal byconducting a thorough critical review of any three research proposals (examples).
  6. Students are expected to develop templates for technical report writing.
  7. Students should conduct a team based mini research project, which is a unified andpractical case on a topic of their choice, with approximately 4-6 students per group.
  8. Students are expected to identify types of plagiarism in academic research, and how toavoid plagiarism in research.
  9. Students are asked to identify and submit a brief report on Indian patents of internationalrepute.
  10. Students are asked to write on Patent registration procedure, and visit Official website ofIntellectual Property India <https://ipindia.gov.in> to know how to get IPR in India.
  11. Students are asked to identity and summarize remedies available against the infringementof intellectual property rights in Indian and global contexts.
- ☐ Students are asked to submit any five examples of ethical issues in copyright and patents.

### **Text and Reference Books:**

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002, An introduction to Research Methodology, RBSA Publishers.
2. Cohen, L. Lawrence, M., & Morrison, K. (2005), Research Methods in Education (5thedition). Oxford: Oxford University Press.
3. Kothari, C.R., 1990, Research Methodology: Methods and Techniques, New AgeInternational.
4. Dornyei, Z. (2007). Research Methods in Applied Linguistics. Oxford: Oxford UniversityPress.
5. Anthony, M., Graziano, A.M. and Raulin, M.L., 2009, Research Methods: A Process of Inquiry, Ally and Bacon.
6. Fink, A., 2009, Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications.
7. Day, R.A., 1992, How to Write and Publish a Scientific Paper, Cambridge University Press.
8. Wadehra, B.L. 2000, Law relating to patents, trade marks, copyright designs and geographical

10. indications. Universal Law Publishing.
11. Coley, S.M. and Scheinberg, C. A., 1990, Proposal Writing, Sage Publications.
12. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: theTRIPS agreement and policy options, Zed Books, New York.
13. Leedy, P.D. and Ormrod, J.E., 2004, Practical Research: Planning and Design, Prentice Hall.
14. Satarkar, S.V., 2000. Intellectual property rights and Copy right. Ess Ess Publications.

#### **Important Websites:**

- [www.ipindia.nic.in](http://www.ipindia.nic.in) - Intellectual Property Office, India
- [www.patentoffice.nic.in](http://www.patentoffice.nic.in) – Patent office, India
- <http://copyright.gov.in/> - Copyright Office, India
- [ipr.icegate.gov.in](http://ipr.icegate.gov.in) – Automated Recordation & Targeting for IPR Protection
- <http://www.icegate.gov.in>- E- Commerce portal of Central Board of Excise and Customs
- [www.ipab.tn.nic.in](http://www.ipab.tn.nic.in) - Intellectual Property Appellate Board, India
- [www.mit.gov.in](http://www.mit.gov.in) – Department of Information Technology, India
- <http://www.mit.gov.in/content/office-semiconductorintegrated-circuits-layout-designregistry>
- Semiconductor Integrated Circuits Layout-Design Registry (SICLDR)
- [www.plantauthority.gov.in](http://www.plantauthority.gov.in) – Plant Varieties and Farmers' Rights Authority, India
- <http://nbaindia.org/> - National Biodiversity Authority
- [www.nipo.in](http://www.nipo.in) – The Indian IPR Foundation
- [www.wipo.int](http://www.wipo.int) – World Intellectual Property Organisation
- <http://www.wto.org> – World Trade Organisation

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | COMPARATIVE ANIMAL PHYSIOLOGY | L | T | P | C | IM | EM | TM  |
|-------------|-------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOODSE201                  | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:**

This course provides detailed knowledge on physiological functions of digestive system, respiratory system, muscle contraction mechanism, excretory physiology, and physiological background of adaptive radiations among the various animals.

❖ **Course Learning Objective(s):**

To make students to understand

- The digestive and respiratory physiology among animals of evolutionary order.
- Diversity in circulation, muscle contraction, and excretory physiology among the animal
- Detailed concept of stress physiology, adaptive radiation among the animal and their physiological background

❖ **Course Learning Outcome(s):**

Student will gain knowledge on the

- Detailed physiological background of digestion, respirations, muscle contraction
- excretion among different animals of evolutionary order
- physiological background of adaptive radiations.

❖ **Course Content:**

**Unit-I : Digestion & Respiration**

General physiological functions and principles, scope of comparative physiology. Digestion - Comparative physiology of digestion and absorption  
Respiration - Respiratory organs and respiratory pigments through different phylogenetic groups, mechanism of oxygen and carbon dioxide exchange.

**Unit-II: Heart & Blood Circulation**

Circulation - Structure and properties of blood. Blood cells and their origin, haemopoiesis, haemoglobin, functions of erythrocytes and leucocytes  
Blood coagulation – Factors affecting coagulation Physiology of heart beat, systolic and diastolic movements.

**Unit-III: Muscle contraction & Neural Transmission**

Muscles - Historical Background – types of muscles and classification, light and electron microscopic structure of skeletal muscles, molecular basis of muscle contraction, sliding filament theory, energetic and thermal aspects of muscle contraction, Twitch, Summation, Tetanus and Fatigue.  
Nervous system - Structure of the nerve, Excitability, Conductivity, refractory period, basis of resting and action potential, all or None principle. Synaptic transmission, neurotransmitters.

#### **Unit-IV: Excretion & Thermal Homeostasis**

Excretion - Comparative physiology of excretion, ultra-filtration in kidney, Homeostatic mechanism of the body, thermal regulation- exothermic and endothermic organisms, physiological mechanism of body temperature regulation.

#### **Unit-V: Stress physiology**

Basic concept of environmental stress and strain, concepts of elastic and plastic strain; stress resistance, stress avoidance and stress tolerance

Adaptation, acclimation and acclimatization.

Physiological adaptation of animals to different environment: Marine environment, shore and Estuaries, freshwater environment, extreme aquatic environments, extreme terrestrial environment.

#### **➤ Text books :**

1. AK. Berry, A Text Book of Animal Physiology, Emkay Publications.
2. Ps Verma, BS.Tyagi, VK.Agarwal, Animal Physiology, S.Chand Publishers
3. EL.Jordan, PS. Verma, Invertebrate Zoology, S.Chand Publishers
4. R.L. Kotpal. Modern text book of Zoology Invertebrates.
5. Veer Balarastogi, Invertebrate zoology
6. Kenneth V. Kardong, Edward J. Zalisko, Comparative Vertebrate anatomy
7. SN.Prasad, V.Kashyap, A Text Book of Vertebrate Zoology, New Age International Publishers
8. R.L. Kotpal, Modern text book of Zoology Vertebrates.

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | TOXICOLOGY   | L | T | P | C | IM | EM | TM  |
|-------------|--------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOODSE202 | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:**

This course provides the basic information on various sources of toxicants in to the ecosystem, food, and method of evaluation of toxicants, different health hazards through toxicants, etc.

❖ **Course Learning Objectives:**

To make students to aware of

- The concept of toxicology, history, toxicology tests, exposure to toxicants, bioaccumulation and
- Bio magnification, heavy metals in the environment, radiation and its health effects.

❖ **Course Learning Outcomes:** Student will gain knowledge on

- the scope and importance of toxicology and classification of toxicants. –
- A student will be able to understand the types of toxicity tests and the concept of dose response relationship.
- A student will be able to understand the sources and toxicity of heavy metals and carcinogens.

❖ **Course Content :**

**Unit – I**

General Account and definition of toxicology. History of Toxicology (The Early Era, The Middle Age, Recent Developments in toxicology). Disciplines of toxicology (Environmental toxicology, Food & drug toxicology, Industrial toxicology etc.). Scope & importance of Environmental toxicology. Toxicants and their classification - Definition of toxicant; Toxicants into the Ecosystems; Classification of toxicants (toxicants in air, toxicants in water).

**Unit – II**

Toxicity tests. Categories of Toxic Effects. Types of toxicity test (test types based on number and condition; Test types based on exposure of toxicants). Acute toxicity test (definition, objectives of acute toxicity test). Bioassay and types of Bioassays. Maximum acceptable toxicant concentration (MATC). Concept of Dose-Response relationship, measurement of Dose-Response relationship, LD50 and LC50. Dose-Response curves, potency and toxicity. Threshold dose and no observed effect and margin of safety.

**Unit – III**

Exposure of Toxicant - Routes and sites of exposure. Duration and frequency of exposure and types of human exposure. Toxicology of pesticides - classification of pesticides. Environmental impact of pesticides. Bioaccumulation and biomagnification in food chain. Case study of - DDT in the environment. Ammonia & H<sub>2</sub>S detoxication and biotransformants.

**Unit – IV**

Heavy metals in environment: Uses and pollution sources, toxicity, biochemical effects and remedial measures of Arsenic, Cadmium, Lead, Mercury and Chromium. Environmental carcinogens- Introduction; Characteristics of Cancer and Cancer cells; Effect of Cancer; Types of Cancer (brief);

Causes of Cancer. Environmental carcinogens- Types of Carcinogens (based on chemical nature, based on mode of action).

#### **Unit – V**

Radiation and Health- Types and sources of ionizing radiation. Units of Radiation. Biological effects of ionizing radiation. Epidemiological issues goiter, fluorosis and arsenic poisoning.

#### **Text books :**

1. Concepts of Toxicology by Dr. Omkar, Vishal Publishing Company.
2. Fundamentals of Toxicology by Dr. Kamleshwar Pandey, Dr. J. P. Shukla, Dr. S. P. Trivedi, New Central Book Agency.
3. Environmental Chemistry by A. K. De, New Age International Limited, Publishers.
4. Environmental Science by S. C. Santra, New Central Book Agency.
5. Environmental biology and Toxicology by Sharma P.D., Rastogi and Lamporary

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | ENTOMOLOGY   | L | T | P | C | IM | EM | TM  |
|-------------|--------------|---|---|---|---|----|----|-----|
| Course Code | 25 ZOODSE203 | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

❖ **Course Description and Purpose:**

This course provides the basic information on the fundamental classification of insects, beneficial insect, harmful insects, and integrated pest management, eco-friendly pest control

❖ **Course Learning Objective(s):**

To make students to understand -To make students to understand and familiarize with insect pests and to understand about the insect ecology.

❖ **Course Learning Outcome(s):** - Student will gain knowledge on the “logical approaches in taxonomy of insects, important several useful and harmful insects, eradications/ control method - etc.”

❖ **Course Content :**

**Unit- I**

History of Entomology. Classification of phylum Arthropoda. Relationship of class Insecta with other classes of Arthropoda. Insects in relation to man - Factors for insect abundance and success. Morphology –Grasshopper/Plant bug, structure and functions of insect cuticle, Moulting. Body segmentation. Structure of Head, thorax and abdomen .Structure and modifications of insect mouth parts. Types of insect larvae and pupae.

**Unit- II**

Insect orders of agricultural importance- Lepidoptera, coleoptera, hemiptera, diptera and hymenoptera.

**Unit- III**

Insect Ecology- introduction. Environment and its components. Population dynamics- effect of abiotic factors- temperature, moisture, humidity, Rainfall, light, atmospheric pressure and air currents. Effect of biotic factors - food, natural enemies, pheromones, prey and Predator relationships.

**Unit-IV**

Concepts of Balance of life in nature, biotic potential and environmental resistance. Pests - definition, categories of pests, causes for pest outbreak. Losses caused by pests. Integrated pest management, and integrated nutrition management.

**Unit-V**

Identification, symptoms of damage caused by pests of Rice, Coconut, Banana, Pepper, cardamom, Brinjal, Bittergourd and cowpea. Nematode Pests of crops, Common Pests of stored food products/grains. Pest monitoring - Pest surveillance and pest forecasting. Assessment of pest population and damage. - Student will gain knowledge on the insect pests and to understand about the insect ecology

**Text books :**

1. Mani, M. S. 1968. General Entomology. Oxford and IBH Publishing Company, New Delhi.
2. Nayar, K. K., Ananthakrishnan T. N. and David.B.V. 1976. General and Applied Entomology, Tata McGraw Hill Publishing Company Limited, New Delhi, 589p.
3. Pedigo, L. P. 1999. Entomology and Pest Management. Third Edition. Prentice Hall, New Jersey, USA
4. Richards, O.W. and Davies, R. G. 1977. Imm's General Text Book of Entomology, Vol.1&2, Chapman and Hall Publication, London.
5. Srivastava, P. D. and Singh, R. P. 1997. An Introduction to Entomology, Concept Publishing Company, New Delhi.

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | BIO-ANALYTICAL<br>TECHNIQUES &<br>SYSTEMATIC OF<br>VERTEBRATES | L | T | P | C | IM | EM | TM  |
|-------------|----------------------------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOOL201                                                      | 0 | 0 | 6 | 3 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

➤ **List of Experiments**

➤ **Bioanalytical techniques**

1. Separation of amino acids by paper chromatography.
2. Separation of amino acids/ sugars/ lipids by Thin Layer Chromatography.
3. Ultra violet absorption spectra of nucleic acids and proteins.
4. Gel filtration of proteins.
5. Ion exchange chromatography of amino acids.
6. Purification of enzyme by affinity chromatography.
7. Polyacrylamide gel electrophoresis of proteins.
8. Estimation of reducing sugars by Benedict's titrimetric method.
9. Estimation of total carbohydrates by anthrone method.
10. Estimation of proteins by Lowry and Bradford methods.
11. Estimation of ascorbic acid.

➤ **Systematic of Vertebrates & Wild life conservation**

1. Specimens and spotters of Chordates
2. Endangered and threatened animal species of India: Aquatic, Terrestrial and Aves
3. Hot spots of India
4. Sanctuaries, national parks and biosphere resources
5. Ramsar Convention
6. Conventions on biological diversity
7. Species diversity indices
8. RED Data
9. Gene banks
10. Cryopreservation

KRISHNA UNIVERSITY:: MACHILIPATNAM  
DEPARTMENT OF BIOSCIENCES AND BIOTECHNOLOGY  
**11. M.Sc. – ZOOLOGY, II SEMESTER**

| Course Name | ANATOMY OF<br>INVERTEBRATES AND<br>VERTEBRATES &<br>COMPARATIVE<br>ANIMAL PHYSIOLOGY | L | T | P | C | IM | EM | TM  |
|-------------|--------------------------------------------------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOOL202                                                                            | 0 | 0 | 6 | 3 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

➤ **List of experiments**

➤ **Anatomy of Invertebrates and Vertebrates**

1. Nervous system of Sepia/Loligo
2. Mounting : Nephridium and Spermatheca in Earthworm
3. Respiratory system : Mounting of gill in prawn,
4. Scoliodon : mounting of placoid scales
5. Anabas : Accessory respiratory organs
6. Nauplius, Zoea, Mysis, phyllosoma, Trilobite larvae of Limulus, Velliger, Bipinnaria, Ophiura and Echinopluteus, Auricularia, Tornaria, Trochophore.

➤ **Comparative Animal Physiology**

1. Estimation of metabolic rate of fish
2. Estimation of proteins
3. Qualitative identification and estimation of Ammonia, Urea, Uric acid
4. Qualitative determination of digestive enzymes, Cellulose, Amylase, Pepsin, Trypsin, and Lipase
5. Estimation of Haemoglobin
6. RBC count by Haemocytometer
7. Osmotic regulation – Earthworm experiment

### III-SEMESTER

#### Paper Code & Title: 25ZOO301: Molecular Biology and Animal Biotechnology

| Course Name | Molecular biology & Animal Biotechnology | L | T | P | C | IM | EM | TM  |
|-------------|------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOO301                                 | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

#### Course Description and Purpose:

##### Course Learning Objective(s):

- To make students to understand and gain knowledge on structure and major functions of nucleic acids.
- Get to know transcription, translation and post translational modifications
- Gain knowledge on transgenic animal's production process etc.

#### UNIT – I

Organization of Genetic material - Packing of DNA into chromatin - protein components of chromatin, histones, nucleosome organization. Solenoid loops, domains and scaffolds. Gene amplification, polytene chromosomes. Nuclear genome. C - value paradox. Mitochondrial and plastid genomes. DNA replication – enzymes involved and mechanism of replication in prokaryotes and eukaryotes.

#### UNIT – II

Transcription in prokaryotes and eukaryotes. RNA polymerases, DNA binding domains in transcription factors - zinc finger, leucine zipper, helix-loop-helix and helix turn helix. Mechanism of transcription. Maturation and processing of m-RNA - splicing, 5' end capping and 3' end tailing. Alternative splicing. RNA editing and transport. RNAi and small RNAs.

#### UNIT – III

Translation in prokaryotes and eukaryotes. Genetic code - properties of the genetic code, deciphering of the genetic code. Ribosome as a translation factory. t - RNA as an adaptor, its mode of function. Post-translational modifications. Protein targeting.

#### Unit-IV

Production of transgenic animals - mice, sheep and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential applications of transgenic animals. Animal models for diseases and disorders. Transgenic poultry and transgenic insects as bioreactor. Genetically engineered animals and environmental health, Hazards of genetically engineered animals, Policies of genetic engineering research in India

#### Unit-V

Applications of biotechnology to animal health - Production of vaccines, diagnostics, hormones and other products. Biotechnology in animal production-manipulation of growth and reproduction using hormones and probiotics, manipulation of lactation, production of vaccines for better health. Biotechnology in biodiversity and conservation, Cryopreservation, gene-banks.

#### Practicals :

1. DNA isolation from human Cheek cells
2. Qualitative test of DNA by DPA method.
3. Estimation of DNA by DPA method.
4. Demonstration of Polyacrylamide gelelectrophoresis (PAGE)
5. Demonstration of Southern Blotting and Northern Blotting.

6. PCR demonstration

**Course Learning Outcome(s):**

- Student will gain knowledge on the

**Text books :**

**Reference books:**

1. Gupta, P.K. Elements of Biotechnology
2. Singh, B.D. Biotechnology
3. Balasubramanian, Concepts in Biotechnology

➤ **E- content / E-books (optional)**

**Paper Code & Title: 25ZOODSE301: Immunology and Parasitology**

| Course Name | Immunology and Parasitology | L | T | P | C | IM | EM | TM  |
|-------------|-----------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE301                 | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Description and Purpose:****Course Learning Objective(s):**

To make students to understand the

**Unit – I**

The Immune System: Introduction - Cells of the Immune system - Innate and Acquired immunity - Primary and secondary lymphoid organs – Nature of antigens - Chemical and molecular basis of antigenicity – Immunogenicity- Haptens- Adjuvants - Primary and Secondary Immune Responses - Theory of Clonal selection.

**Unit – II**

Humoral Immunity: B-lymphocytes and their activation - Structure and function of Immunoglobulin - Isotypes of immunoglobulins, antibody diversity Antigen-Antibody interactions - Antibody affinity- avidity; Agglutination – Precipitation - Idiotypic antibodies - monoclonal antibodies - antibody engineering – Major Histocompatibility Complex.

**Unit – III**

Cell Mediated Immunity: Biology of T lymphocyte - Classification of T lymphocytes - Structure of T Cell Receptor (TCR) - Antigen presenting cells (APC) – macrophages - dendritic cells - Origin and functions of APC - Antigen processing and presentation, autoimmunity.

Cell mediated cytotoxicity - mechanism of T-cell and NK cell mediated lysis - Complement- Hypersensitivity. Tumor Immunology - Vaccines: Conventional- Molecular vaccines -Types of vaccines - Recent trends in Immunology of Infectious diseases.

**Unit – IV**

Introduction of parasitology, Types of parasites, Adaptations for parasitic life Parasitic interaction of Entamoeba and Giardia- medication and mechanism of drug action, Life cycle of Plasmodium – Prophylaxis and treatment.

**Unit – V**

Biology, lifecycle and portal entry of *Dipyllobothrium latum*- Prophylaxis and treatment Biology, lifecycle and nature of infection of *Wuchereria Bancrofti*- Prophylaxis and treatment.

**Practicals :**

1. Blood Film Preparation and identification of cells. Differential count of WBC, RBC
2. Blood typing
3. Phagocytosis of RBC by Macrophage and in vitro assay
4. Lymphoid organs and their microscopic organization.
5. Demonstration of Immuno-electrophoresis.
6. WIDAL test & VDRL test
7. HCG detection in Urine
8. Demonstration ELISA

9. Slides of parasites

**Reference books:**

1. Kuby, J. Immunology. W.H. Freeman and Company, New York. 2002
2. Abul K. Abbas, Andrew K. Lichtman & Jordan S. Pober (Eds.). Cellular and Molecular Immunology. 3rd Edn. W.B. Saunders Company, 2001
3. Ivan Roitt, Essential Immunology, 10th Edn. Blackwell Scientific Publication, , 2002, 2. Weir DM and Stewart, J., Immunology, 10th Edn. Churchill Livingstone, New York, 2000.
4. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts and James D Watson (Eds.) Molecular Biology of the Cell (5th Edn), 2000,.
5. Ivan Roitt, Jonathan Brostoff, David Male (Eds.), , Immunology, 5th Edn., Mosby Publication, 2002.
6. T.J. Parker and W.A. Haswell. Text book of zoology, Vol.2
7. Vertebrates (Eds.), A.J. Marshall, ELPS and MacMillan, 1972.
8. R. L. Kotpal, Modern text book of zoology vertebrates.
9. J.Z. Young, The life of vertebrates.
10. J.Z. Young, The life of Mammals, Clarendon press, 1966

➤ **E- content / E-books (optional)**

**Paper Code & Title : 25ZOODSE302 : Gamete Biology and Endocrinology**

| Course Name | Gamete Biology and Endocrinology | L | T | P | C | IM | EM | TM  |
|-------------|----------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE302                      | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Learning Objective(s):**

- To make students to understand sexual dimorphism and gonads differentiation.
- To understand the gametogenesis, fertilization and development.
- Acquire knowledge on Importance and role of endocrine system.
- To understand the effect of hormone imbalance in the body

**Course Learning Outcome(s):**

- Students will understand sexual dimorphism and gonads differentiation.
- Understand the gametogenesis, fertilization and development.
- Acquire knowledge on Importance and role of endocrine system.
- Understand the effect of hormone imbalance in the body

**Unit-I**

Differentiation of gonads in a mammal and in an invertebrates, Spermatogenesis, Semen composition and formation and sperm functions.

Ovarian follicular growth and differentiation – Oogenesis and Vitellogenesis, ovulation and ovum transport in mammals. Cryopreservation of gametes

**Unit – II**

Fertilization (species specific recognition of egg and sperm, acrosome reactions, fast and slow block to polyspermy); Cleavage (patterns, molecular mechanism of cleavage).

Stages of development- zygote, blastula, gastrula, neurula, Fate map – construction of fate map, & commitment – potency- concept of embryonic stem cells,

**Unit – III**

Multiple ovulation and embryo transfer technology (MOETT) – Superovulation , In vitro fertilization. ICSI, GIFT, Embryo sexing.

Metamorphosis, Parthenogenesis – Natural parthenogenesis, artificial parthenogenesis, its significance, Regeneration – Types of regeneration and controlling factors.

**Unit – IV**

Introduction to the Vertebrate Endocrine System, Hormones general Characters, Classification of hormones. Hormone action - Receptors-types, structure (insulin, thyroid, steroid and adrenergic receptors)

Hypothalamic Hormones: Synthesis, secretion, transport and biological actions of hypothalamic, adenophysis and neurohypophysis hormones. Hypothalamic and pituitary disorders. Pineal Hormones: melatonin

**Unit – V**

Thyroidal Hormones: function and metabolism, hypo and hyperthyroidism, Parathyroid Hormones: Para hormone and calcitonin, their role in calcium and phosphate metabolism, abnormalities of Parathyroid functions.

Pancreatic Hormone: biosynthesis of insulin and glucagon. Regulation of insulin and glucagon secretion. Role in carbohydrate, lipid and protein metabolism.

## Hormonal regulation of menstrual cycle and pregnancy, hormonal regulation in ageing

### **Pracgticals :**

1. Types of eggs
2. Cleavage, Blastulation, Gastrulation, Frog/Amphioxus/Chick
3. Identification of chick embryo stages 18 to 2 hours-slides
4. Testis Section Human, Ovary Section Human
5. Development stages of frog and mammal-slides
6. Estimation of calcium in egg shell.
7. Mounting spermatozoa – Grasshopper/Frog/Chick/Rat
8. Demonstration class : Pregnancy test using commercial kit

### **Reference books:**

1. Scott F. Gilbert (2006). Developmental Biology, 8th Edition, Sinauer Associates, Inc., Publishers Sunderland, Massachusetts, USA
2. L. Wolpert Rosa Beddington Thomas M. Jessell Peter Lawrence Elliot M. Meyerowitz and Jim Smith (2002) Principles of Development Second Edition Oxford University Press.
3. JMW Slack (2005) Essential Developmental Biology Second Edition Blackwell Publishing Australia.
4. Mac E. Hadley Endocrinology Sixth Edition Prentice hall International, Inc. Arizona (For Section 9).

**Paper Code & Title : 25ZOODSE303: Ecology and Animal Behaviour**

| Course Name | Ecology and Animal Behaviour | L | T | P | C | IM | EM | TM  |
|-------------|------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE303                  | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Description and Purpose:****Course Learning Objective(s):**

To make students to understand the

**Course Learning Outcome(s):****Unit-I**

**Ecosystem:** Scope of ecology, Types of Ecosystems: Natural and engineered ecosystems. Components of ecosystem Biotic & Abiotic). Structure of Aquatic (Pond ecosystem, Ocean/ marine ecosystem), Terrestrial and Estuarine Mangroves) Ecosystems. Trophic levels and Ecological pyramids.

**Ecosystem Functional aspects :** Food chain, food webs, ecological energetics: energy flow and laws of thermodynamics - ecological efficiencies, productivity of ecosystem and Homeostasis

**Unit-II**

Population growth – Natality and Mortality, Biotic Potential and Environmental resistance –Form of population growth – Logistic Curve – Stochastic and time log models of population growth – Optimal yield, Population Regulation – Effects of increased numbers – Harmful Effects – Beneficial Effects, Population – Inter-specific relationships – Positive interactions – Commensalism –Mutualism – Negative interactions – Predation – Parasitism – Antibiosis  
r- & s selection species, survivorship curves

**Unit-III**

Community concept – Community dominance – Ecotone – Community composition – Stratification of community Habitat and Ecological Niche – Ecological Equivalents – Sympatry and Allopatry – Spatial relations of populations – Space requirements – Home range and Territory – Homing and return migration – Emigration edge effect

**Unit-IV**

Ecological aspects of behavior, Habitat selection, food selection, optimal foraging, theory, antipredator defenses, Aggression, homing, territoriality, dispersal, Host – parasite relations Social behavior, Aggregations – Schooling in fishes, flocking in birds, herding in mammals, Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness, Social organization in insects and primates

**Unit-V**

Innate behaviour, Perception of the environment, Chemical, Olfactory, Auditory and Visual. Reproductive behaviour, Evolution of sex and reproductive strategies, Mating systems, Courtship, Sperm competition, Sexual selection, Parental care, Communication, Chemical, Visual, Light, Audio

**Practicals :**

1. Enumeration of Zooplankton Enumeration of macrobenthos
2. Enumeration of microbenthos
3. Creation of Life Table Calculation of net reproductive rate ( $R_0$ ),
4. Generation time (T)
5. Rate of intrinsic growth and optimal age for sexual maturity

6. Calculation of logistic and exponential growth of a given population
7. Zooplankton – Identification (10 examples)

### **Reference books:**

#### **Population ecology**

1. Begon, M., J.L. Harper and C.R. Townsend. Ecology, Individuals, Populations and Communities. Blackwell Science, Oxford, UK.
2. Koromondy, E.J. Concepts of ecology. Prentice Hall, New Delhi.
3. Clarke, G.L. Elements of Ecology, John Wiley & Sons, New York.
4. Odum, E.P. Fundamentals of Ecology. W.B. Saunders, Philadelphia.
5. Krebs, C.J. Ecology. Harper & Row, New York.
6. Jorgensen, S.E. Fundamentals of Ecological modelling. Elsevier, New York.

#### **Animal Behaviour**

1. Alcock, J. Animal behaviour: An evolutionary approach. Sinauer Assoc., Sunderland, Mass, USA
2. Bradbury, J.W. and S.I. Vehrencamp, Principles of animal communication. Sinauer Assoc.
3. Clutton-Brock, T.H. The evolution of parental care. Princeton Univ. Press, Princeton, N.J., USA.
4. Eibl-Eibesfeldt, I. Ethology. The biology of behaviour. Holt, Rinehart & Winston, New York.
5. Gould, J.L. The mechanisms and evolution of behaviour.
6. Hauser, M. The evolution of communication. MIT Press, Cambridge, Mass, USA.
7. Hinde, R.A. Animal behaviour : A synthesis of ethology and comparative psychology. McGraw Hill, New York.
8. Krebs, J.R. and N.B. Davies. Behavioural ecology. Blackwell, Oxford, UK.
9. Wilson, E.O. Sociobiology. The new synthesis. Harvard Univ. Press, Cambridge, Mass, USA.

➤ **E- content / E-books (optional)**

### III SEMESTER

| Course Name | GENETIC<br>ENGINEERING | L | T | P | C | IM | EM | TM  |
|-------------|------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE304            | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

#### Course Description and Purpose:

#### Course Learning Objectives:

- To acquire knowledge on tools and techniques in genetic engineering.
- To gain knowledge in choice of host for cloning, methods of gene transfer and screening procedure.
- To understand the principles and application of PCR techniques, DNA sequencing methods.
- To learn about genetically modified organisms and their benefits.
- To realize ethical issues on genetic engineering.

#### Course Learning Outcomes:

- Technical know-how on versatile techniques in recombinant DNA technology.
- An understanding on application of genetic engineering techniques in basic and applied experimental biology.
- Proficiency in designing and conducting experiments involving genetic manipulation.
- Manipulating DNA sequences with versatile DNA modifying enzymes.
- Designing cloning experiments using routine and specialized vectors for such applications as plant transformation, protein expression and genomic DNA library construction etc.
- Editing genomic sequences using site-directed mutagenesis.
- Employing PCR, nucleic acid hybridization and sequencing technologies for detection and diagnostics.

#### ❖ Course Content

##### UNIT – I:

Genetic Engineering Basic concepts - Overview of recombinant DNA technology. Isolation and purification of genomic RNA and Plasmid DNA. Detection and quantification methods of nucleic acids.

##### UNIT-II

Enzymes used in genetic engineering. Restriction endonucleases - Classification, nomenclature and properties. Restriction mapping. DNA polymerase-I. Polynucleotide kinase. Terminal nucleotide transferase. Reverse transcriptase - structure, mechanism and functions. Alkaline phosphatase. S1 nuclease. DNA Ligases and ligation of foreign DNA to vectors - cohesive and blunt end methods.

##### UNIT – III

Vectors - Salient features of cloning vectors. Types of cloning vectors - plasmids, cosmids, phages (lambda and M13 phage vectors), animal (SV40, Baculo) and plant (CMV) viral vectors. Yeast Artificial chromosomes (YACs). Techniques of gene transfer - transformation, transfection, micro-injection, electroporation, silicon carbide fiber method. Liposome mediated Gene transfer (lipofection). Biolistic Transformation (Gene gun method).

##### UNIT – IV

Selection of Recombinant cells after Gene transfer - Selection of r-DNA clones and their expression. Marker genes and reporter genes. Nucleic Acid Probes. Colony hybridization.

Fluorescent in-situ hybridization. Polymerase Chain Reaction and its applications. Real-Time PCR. Reverse Transcription PCR. DNA microarray technology.

### **UNIT – V: Applications of genetic engineering**

Role of Gene Silencing. Transcriptional gene silencing: DNA structure, eukaryotic gene structure, eukaryotic transcription, genomic imprinting, para-mutation, position effect, RNA directed DNA methylation, transposons, retrotransposons, transposon silencing; transgenes, transgene silencing, transcriptional gene silencing. Post-transcriptional gene silencing: RNA interference: mechanism, Dicer, Drosha, argonautes, miRNA, siRNA, shRNA, piRNA, rasiRNA, tasiRNA, nonsense mediated decay; meiotic gene silencing: Transvection. RNAi therapeutics: cancer, age-related macular degeneration (AMD), RNAi delivery: nanocarriers, nanocarrier mediated delivery.

### **Practicals :**

1. Isolation of genomic DNA from Bacteria
2. Isolation of genomic DNA from animal cell
3. Plasmid DNA isolation
4. RNA isolation
5. Polymerase chain reactions
6. DNA Extractions from agarose gel electrophoresis
7. DNA ligation

### **Text books:**

1. Desmond S. T. Nicholl ,An Introduction to Genetic Engineering, Cambridge University Press, 2018.
2. Mariana Ianello Giassetti, Tatjana Brankov, Genetic Engineering Principles And Methods, Scitus Academics, 2019
3. T.A. Brown. An Introduction to Gene cloning & DNA analysis, 7th edition, Wiley Blackwell, US. 2016.
4. Bernard R. Glick and Cheryl L. Patten, Principles and Applications of Recombinant DNA - Molecular Biotechnology, 5<sup>th</sup> Edition, ASM Press, United States, 2017.
5. T.A. Brown, Genomes 4, Publisher Taylor and Francis, New York, 2018.
6. Bernard R. Glick, Cheryl L. Patten. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th Edition Publisher, 2017.
7. Isil Aksan Kurnaz, Techniques in Genetic Engineering, Publisher CRC Press, 2021.
8. Walter E. Hill, Genetic Engineering A Primer, Publisher CRC Press, 2019.

### **e-Reference links**

1. <https://www.pdfdrive.com/molecular-biotechnology-principles-and-applications-of-recombinant-dna-e156918014.html>
2. <https://www.pdfdrive.com/recombinant-dna-technology-molecular-biology-and-paradigms-e11385991.html>
3. <https://www.pdfdrive.com/recombinant-dna-principles-and-methodologies-e185941491.html>

**Paper Code & Title: 25ZOODSE305: Dairy Technology**

| Course Name | Dairy Technology | L | T | P | C | IM | EM | TM  |
|-------------|------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE305      | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Description and Purpose:****Course Learning Objective(s):****Course Learning Outcome(s):****Unit-I**

Introduction, Common terms and Definitions in Animal Husbandry. Cattle and Buffalo population and its distribution; Milk production Statistics; Breeds of Dairy cattle, Buffaloes and Goats. Indigenous, Exotic and Cross bred Cattle breeds.

**Unit-II**

Systems of Dairy cattle breeding. Inbreeding, Outbreeding, Cross breeding, Grading up. Breeding systems suitable to enhance milk production in India (Cross breeding of cattle and Grading up of buffaloes). Multi-ovulation and Embryo transfer technique. Cloning and Transgenic animals.

**Unit-III**

Physico-chemical properties of milk – Colour, Flavour, Density, Specific gravity, Freezing point, Boiling point, Surface tension, Viscosity, Specific heat, Refractive index, Electrical conductivity, Germicidal property, pH and acidity. Methods of Pasteurization: LTLT, HTST and Uperization. Sterilization of milk. Factors influencing homogenization, effect of homogenization on milk. Standardization of milk.

**Unit-IV**

Packaging of milk: Desirable characters and types of packaging materials; Forms of packaging. Disposal of dairy effluents: Sources of dairy waste; Necessity of treatment of dairy waste; Methods of treatment: Low cost methods and Conventional methods

**Unit-V**

Market milk: Toned milk, Double toned milk, Reconstituted milk, Standardized milk and Full cream milk – Standards and methods of manufacture. Cream: Types of cream, composition, methods of cream separation, gravity and centrifugal methods, types of cream separators; factors affecting fat losses in skim milk and fat percentage in cream.

**Practicals :**

1. Determination of physico-chemical properties of milk.
2. Testing efficiency of pasteurization of milk
3. Detection of adulterants of milk
4. Separation of cream from milk
5. Preparation of flavoured milk.
6. Preparation of all Indian traditional dairy products.

**Reference Books:**

Dairy processing handbook – Gosta Bylund.

Outlines of Dairy Technology – Sukumar De.

Milk products preparation and quality control – C.P. Ananthakrishnan.

The technology of milk processing – C.P. Ananthakrishnan.

Modern Dairy products – Lincoln M. Lampert.

**Paper Code & Title: 25ZOODSE306: Limnology**

|             |             |   |   |   |   |    |    |     |
|-------------|-------------|---|---|---|---|----|----|-----|
| Course Name | Limnology   | L | T | P | C | IM | EM | TM  |
| Course Code | 25ZOODSE306 | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

**L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks**

**Course Description and Purpose:****Course Learning Objective(s):**

To make students to understand the

**Course Learning Outcome(s):****Unit-1**

Definition and facts of Limnology. Limnology as an applied science. Light: penetration and zonation in natural waters. Compensation point. Factors effecting light penetration in natural water and fish pond.

**Unit-II**

Temperature: direct and inverse stratification and its overall impact. Thermal bar. Thermal classification of lakes.

**Unit-III**

Dissolved gases in the lakes and fish pond. Oxygen. Sources, losses and spatial and temporal distribution patterns. Algal die-offs. Identification of oxygen depletion problems and control mechanisms. Carbon dioxide: sources, losses and distribution patterns. Carbon dioxide system in chemical buffering. Redox potential and its implications.

**Unit-IV**

Nutrients: Biogeochemical cycling of phosphorous and nitrogen. Macro and micro-nutrients in fish pond. Primary nutrients in fish ponds. Properties of chemical fertilizers.

**Unit-V**

Management of natural water bodies. Biomanipulation concept: Zooplankton as a tool in lake management. Turbidity: causes, consequences and control. Liming and its implications in fish pond

**Practicals :**

1. Determination of pH, Temperature, Turbidity, and COD & BOD of water
2. Collection, preservation and identification of common phytoplanktonic organisms in the pond.
3. Collection, preservation and identification of common zooplanktonic organisms in ponds – rotifers, copepods and cladocerans.
4. Estimation of relative abundance of different groups using counter-Numerical analysis and quantitative estimation
5. Collection, preservation and identification of benthos.
6. Acquaintance with the common floating, emergent and submerged aquatic vegetation.

**Recommended Books:**

Wetzel.R.G.1983, limnology. W.B. Saunders Co.

Goldman.C.R.& A.J. Horne, 1983, Limnology, McGraw Hill International Book Co.

Cole.G.A. 1983, Limnology, The C.V. Mosby Co.

Reid. G.K & R.D. Wood, 1976, Ecology of inland waters and Estuaries, D.Van Nostrand Co. New York.

Welch P.S. 1952, Limnology, McGraw-Hill Book Co.

Kerfoot. W.C. & A. Sih. 1987, Predation: Direct and indirect impacts. Univ. Press of New England, Hanover & London.

Carpenter. S.R. & J.F. Kitchell (eds), 1993. The Trophic Cascade in lakes. Cambridge Univ.Press.

**Paper Code & Title : 25ZOOLAB301: Molecular Biology & Animal Biotechnology & practical component of 1<sup>st</sup> elective of DSE**

|             |                                                                                                |   |   |   |   |    |    |     |
|-------------|------------------------------------------------------------------------------------------------|---|---|---|---|----|----|-----|
| Course Name | Molecular Biology & Animal Biotechnology & practical component of 1 <sup>st</sup> selected DSE | L | T | P | C | IM | EM | TM  |
| Course Code | 25ZOODSE301                                                                                    | 0 | 0 | 6 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Paper Code & Title : 25ZOOLAB302: Practical component of 2<sup>nd</sup> and 3<sup>rd</sup> selected DSE**

|             |                                                                         |   |   |   |   |    |    |     |
|-------------|-------------------------------------------------------------------------|---|---|---|---|----|----|-----|
| Course Name | Practical component of 2 <sup>nd</sup> and 3 <sup>rd</sup> selected DSE | L | T | P | C | IM | EM | TM  |
| Course Code | 25ZOOLAB302                                                             | 0 | 0 | 6 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Paper Code & Title: 25ZOOOE301: Apiculture (HONEY BEE FARMING)**

| Course Name | Apiculture (Honey Bee Farming) | L | T | P | C | IM | EM | TM  |
|-------------|--------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOO OE 301                   | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Learning Objective:**

- To inculcate importance of Bee keeping and honey processes in relation with entrepreneurship development.
- To give students knowledge about various techniques of Bee keeping and honey processing and its marketing to make them self sustainable after graduation.
- To teach techniques of construction of Bee Hives and its maintenance.
- To teach students about Honey production and health related problems with Honey bees, Importance of honey
- Students will learn important steps in bee keeping and bee hive handling without fear.
- Students will learn the use of different equipments in bee keeping.

**UNIT-I**

Introduction to Apiculture/Bee keeping - scope, importance. Definition and role of bee keeping in India as a source of employment. Traditional bee keeping, Modern beekeeping. Role of Central Honey Bee Research & Training Institute, Pune.

**UNIT – II**

Honey Bee morphology, Anatomy and Life cycle. Morphology of Honey bees – Difference in indigenous and exotic honey bees, Life cycle and Parthenogenesis in honey bees.

Honey bee identification and systematic position. Colony life and social organization in honey bees–Queen, drone, worker. Honey bee as a pollinator.

**UNIT – III**

Honeybee Enemies and Diseases. Bee enemies– Wax Moth, Ants, Wasps, Bacterial disease -American Foul brood. Viral disease - Deformed Wing Virus / Kashmir Bee Virus ,Fungal disease - Chalkbrood, Protozoan disease – Nosemosis.

**UNIT – IV**

Handling of parts of artificial hive / Bee box, Different tools used in Bee keeping.

Identification of Queen cells, Drone cells & Brood cells.

Methods of Extraction of Bees wax, Royal Jelly and Bee venom.

Extraction of Honey using Honey extractor, moisture reduction, packing and storing of Honey study of natural enemies and predators of Honey Bees - management involved.

**UNIT-V**

Honey processing and its properties and application in various fields (6 L) Honey - its medicinal properties -- other valuable by products of honey bees. Modern method of honey processing, Packing and Marketing. Value added honey products , Nutrients and composition of honey, Acid content and flavor effects. Types of value added honey product

**Learning Outcomes**

- The learner will able to differentiate in different types of honey bee castes.
- Learner will be able to use the artificial hive for beekeeping
- Learner will be able to use the technique of honey purification and processing.

- Learner will be able to construct the artificial honey hive and maintain it.
- Learner if is not employed can find own employment by doing Bee keeping
- Lerner can start own beekeeping equipment agency for farmers or beekeepers.

**Paper Code & Title: 25ZOOOE302: SOIL AND WATER CHEMISTRY**

| Course Name | SOIL AND WATER CHEMISTRY | L | T | P | C | IM | EM | TM  |
|-------------|--------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOO OE 302             | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Unit-I**

Standard solutions, dilute solutions units of concentration: standard curve; nomograph. Chemistry of water; the water molecule, properties of pure water and sea water. Composition of surface water, ground water and Sea water. Dissolved gasses. Factors affecting natural waters. Acid, base, salts; Hydrogen ions, concept of pH and buffer.

**Unit-II**

Water analysis: collection and preservation of water samples. Measurement of temperature. Transparency, turbidity, determination of pH, electrical conductivity, salinity, Chlorinity, total solids (TDS, TSS, TVS, TVDS). Dissolved Oxygen, free carbon dioxide, total alkalinity, total hardness, Calcium, Magnesium, Inorganic Nitrogen (ammonium and Nitrate) and phosphorus. Water quality criteria/ requirements for Aquaculture.

**Unit-III**

Soil characteristics: origin and nature of soils. Physical properties of soil; soil color. Soil texture, soil structure, pore size, bulk density, water holding capacity, soil types and their distribution. Soil chemistry: soil colloids, cation exchange, organic Carbon, Carbon – Nitrogen ratio, soil fertility, soil reaction: Acidity, Alkalinity, Conductivity, Redox potential. Submersed soils, wet lands, fluxes between mud and water, methane and hydrogen sulphide formation.

**Unit-IV**

Saline soils, Alkali soils, acid sulphate soils, iron pyrites, soil reclamation. Soil analysis: collection and preparation of soil samples. pH, conductivity, organic carbon , nitrogen, phosphorus, lime requirement. Soil quality criteria/ requirements for aquaculture.

**Unit-V**

Soil and water amendments: lime manures, fertilizers, micronutrients, zeolites , alum, gypsum, environmental ameliorative: chlorination, deodorizers, bacterial formulation.

**Paper Code & Title: 25ZOOOE303: Environmental Studies**

|             |                       |   |   |   |   |    |    |     |
|-------------|-----------------------|---|---|---|---|----|----|-----|
| Course Name | Environmental Studies | L | T | P | C | IM | EM | TM  |
| Course Code | 25ZOO OE 302          | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

Definition, Scope and importance, Need for public awareness on Environment. **NATURAL RESOURCES** : Introduction, Renewable and non-renewable resources - forest resources, water resources, mineral sources, food resources, energy resources, land resources etc., Role of an individual in conservation of natural resources, Equitable use of resources for sustainable lifestyles.

**ECOSYSTEMS** : Concept of an ecosystem, Structure and functions of an ecosystem, Producers, consumers and decomposers, Energy flow in the ecosystem, Ecological succession, Food chains, Food webs and Ecological pyramids, Introduction, Types, Characteristic features, Structure and functions of - Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems ( ponds, lakes, streams, rivers, estuaries, oceans ).

**BIODIVERSITY AND ITS CONSERVATION** : Introduction - definition of genetic, species, ecosystem diversity, Biogeographic classification of India, Value of biodiversity - consumptive, productive use, social, ethical, aesthetic and option values, Biodiversity at global, national and local levels, India as a mega diversity nation, Hotspots of biodiversity, Threats to biodiversity - habitat loss, poaching of wildlife, man - wildlife conflicts, Endangered and endemic species of India, Conservation of biodiversity : in-situ and ex-situ.

**ENVIRONMENTAL POLLUTION** : Definition, Causes, effects and control measures of - Air Pollution, Water Pollution, Soil Pollution, Marine Pollution, Noise Pollution, Thermal Pollution & Nuclear hazards, Solid waste management - causes, effects and control measures of urban and industrial waste, Role of individuals in pollution prevention, Pollution case studies, Disaster management - floods, earthquakes, cyclones, landslides.

**SOCIAL ISSUES AND THE ENVIRONMENT** : From unsustainable to sustainable development, Urban problems related to energy, Water conservation, rain water harvesting, watershed management, Resettlement and rehabilitation of people; its problems and concerns - case studies, Environmental ethics - issues and possible solutions, Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and nuclear holocaust - case studies, Wasteland reclamation, Consumerism and waste products, Environment protection act, Air (prevention and control of pollution ) act, Water (prevention and control of pollution) act, Wildlife protection act, Forest conservation act, Issues involved in enforcement and environmental legislation, public awareness.

## M.Sc. ZOOLOGY, IV-SEMESTER

### Paper Code & Title: 25ZOO401: Evolution and Population Genetics

| Course Name | Evolution and Population Genetics | L | T | P | C | IM | EM | TM  |
|-------------|-----------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOO401                          | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

### Course Description and Purpose:

### Course Learning Objective(s):

### Course Learning Outcome(s):

#### Unit-I

Introduction to evolution theory, Darwin and the theory of evolution, Natural selection, The Modern Synthesis, Evolution populations. Hardy Weinberg law of genetic equilibrium, and estimating allele frequencies, Assumptions and testing Hardy-Weinberg principle, An introduction to Bayesian inference, Factors affecting human diseases frequency.

#### Unit – II

Quantitative genetics: Introduction, polygenic traits and mode of inheritance, Multifactorial inheritance, Quantifying genetic variability, Genetic structure of natural populations, Phenotypic variation.

#### Unit – III

Genetics of quantitative traits in populations, Analysis of quantitative traits, Quantitative traits and natural selection, habitability, Inbreeding and its consequences, Co-efficient of inbreeding and consanguinity, inbreeding depression and Heterosis: Genetic and environmental factors

#### Unit – IV

Genetics of speciation, Phylogenetic and biological concept of species, Patterns and mechanisms of reproductive isolation. Models of speciation (Allopatric, Sympatric, Parapatric), Molecular evolution, Gene evolution, Evolution of gene families, Molecular drive

#### Unit – V

Origin of higher categories, Phylogenetic gradualism and punctuated equilibrium, Micro- and macro-evolution. Molecular Phylogenetics, Construction of Phylogenetic trees. Molecular tools for phylogenetic trees – Immunological techniques, Amino acid phylogeny, Nucleotide sequence comparison and homologies, Restriction enzyme phylogenies, Molecular clocks.

Human genome project and Pedigree analysis

### Practicals :

1. Modes of inheritance – Mendelian inheritance, Gene interaction, Multifactorial inheritance (finger printing), sex-linked inheritance.
2. Population genetics – Calculating the gene frequencies and genotype frequencies for autosomal dominant traits, Autosomal recessive traits employing binomial distribution
3. Quantitative genetics – Mean, Standard Deviations, Chi-square & Variance.

### Reference books:

1. Dobzhansky, Th. Genetics and origin of Species. Colombia University Press

2. Dobzhansky, Th., F.J. Ayala. G.L. Stebbens and J.M. Valentine. Evolution, Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutionary Biology. Suinuaer Associates, INS Publishers, Dunderland
4. Hartl, D.L. A Primer of population genetics. Sinauer Associates, INC, Massachusetts
5. Jha, A.P. Genes and Evolution, John Publication, New Delhi
6. King, M. Species Evolution – the role of chromosomal change. The Cambridge University Press, Cambridge.
7. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston, London.

➤ **E- content / E-books (optional)**

**Paper Code & Title: 25ZOODSE401: Biotechnological Applications in Aquaculture**

| Course Name | Biotechnological Applications in Aquaculture | L | T | P | C | IM | EM | TM  |
|-------------|----------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE401                                  | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Learning Objective(s):**

- To understand the natural, supplementary feeds, probiotics, nutraceuticals and growth promoters in aquaculture.
- To impart knowledge on culture of live feeds.
- To understand the applications of genetics in aquaculture.
- To know the various hormones and their uses in induced breeding of finfish and shellfish.
- To understand the applications of biotechnology in aquaculture.

**Course Learning Outcome(s):**

- Obtain knowledge on uses of natural and supplementary feeds, probiotics and nutraceuticals in aquaculture.
- Acquire knowledge on culture of live feeds.
- Obtain knowledge on application of genetics in aquaculture for production of quality cultivable species.
- Acquire knowledge on induced breeding in finfish and shellfish.
- Acquire knowledge on biotechnology in aquaculture.

**Unit – I**

Role of Biotechnology in aquaculture, Nutritional biotechnology: Principles of nutrition – nutritional requirements of cultivable finfish and shellfish at different stages of life, Energetics of food conversion. Growth promoters, probiotics and prebiotics.

Sources of food: natural and artificial feeds. Live feeds: collection, culture and their utilization. Artificial feeds: feed formulations, methods & strategies. Importance and use of anti-oxidants and antibiotics in feeds, Feed storage.

**Unit – II**

Reproductive Biotechnology: Breeding biology and endocrine control of reproduction in finfish and shellfish.

Induced breeding, Egg incubation and Larval rearing.

**Unit – III**

Principles of genetics: fish cytogenetics; Application of genetics in aquaculture: genetic selection, hybridization, inbreeding, and cross-breeding,

Sex control, cryopreservation, In-vitro fertilization, artificial insemination, polyploidy and transgenesis, Development of disease-resistant and high quality strains.

**Unit – IV**

Aquaculture biotechnology- Aquaculture: culture of shrimp, crab, edible molluscs, oysters and pearl oysters, Culture of milkfish, mullets and eel. Culture of live feed organisms- shrimp, rotifers, marine algae.

Hormonal manipulation of sex. Chromosomal manipulation of sex in fish. Hormonal manipulation of induced breeding. Disease Diagnostics: ELISA, FISH and PCR

## Unit – V

Indian scenario in Aquaculture: Introduction and initiatives, ICAR (Indian council of Agricultural Research): CMFRI, CIFRI, CICFRI, CIFA, CIBA, CIFT, CIFE, NBFGR, NRCCWF; Ministry of Agriculture: CIFNET, CICEF, IFP; Ministry of Commerce: MPEDA, EIA, IIP, IIFT; Ministry of Food Processing Industries

### **Practicals :**

1. Estimation of water quality parameters: Dissolved oxygen, pH, Salinity, Ammonia, Nitrates, Nitrites, Phosphates.
  2. Identification and partial characterization of fish and shrimp pathogens
  3. Polyploidy detection using karyotyping
  4. PCR diagnosis of white spot syndrome virus, monodon baculovirus, hematopoietic necrosis virus.
  5. Immunodiagnosis of fish pathogen (Western blot)
  6. Enrichment of live feed organisms Artemia, Rotifers
  7. Induction of breeding in fish using ovaprim-in vitro fertilization and rearing of Fry.
- Field visit to shrimp hatchery, farms and salt pans.

### **Course Learning Outcome(s):**

- Student will gain knowledge on the

### **Reference books:**

1. Aquaculture: Principles and Practices - T.V.R. Pillay -1990
2. Marine Microbiology - Austin. Cambridge press.1992
3. Aquaculture: The farming and husbandry of Freshwater & Marine organisms by J.Bardach, Ryther J. McLaren W. 1972.
4. Advances in Fisheries Technology and biotechnology for increased profitability - Ed. Michael N. Voigt, J. Richard Botta. Technomic Publishing Co. Inc.(1990)
5. Biotechnology in the Marine Science- Proceedings of the first Annual MIT Sea Grant Lecture and Seminar - Colwell R.R. 1982.
6. New Developments in Marine Biotechnology Ed. LeGal and H.O.Halvorson Plenum press 1998.
7. Italy, E (Eds). 1998, New Developments in Marine Biotechnology, Plenum Pub. Corp.
8. Milton Fingerman and Rachakonda Nagabhushanam, 1996, Molecular Genetics of Marine Organisms, Science Pub Inc.
9. Y. Le Gal and H.O.Halvorson 1998, New Developments in Marine Biotechnology. Springer.
10. David H. Attaway, 2001. Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
11. Rita R. Colwell 1984. Biotechnology in the Marine Sciences (Advances in Marine Science & Biotechnology) Wiley Interscience.
12. Scheupr, P.J. (Ed.), 1984. Chemistry of Marine Natural Products, Chemical and Biological Perspectives. Vol. I III, Academic Press, New York.

### **➤ E- content / E-books (optional)**

**Paper Code & Title: 25ZOODSE402: Industrial Zoology**

| Course Name | Industrial Zoology | L | T | P | C | IM | EM | TM  |
|-------------|--------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE402        | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Learning Objective(s):****Course Learning Outcome(s):****Unit –I**

Introduction to household insects, life cycle, loss, and control measures for Termites (white ants), Black ants, Clothes moths & Housefly

Insect pest control – various aspects of insect pests, classification of insect pest control measures, insecticides-formulations, classification, Biological control.

**Unit – II**

Sericulture –Types of silk worms, life history of Bombyxmori, diseases and its predators, types and properties of silk.

Apiculture – types of bees, life cycle of honeybee, swarming, nuptial flight, absconding, supersedure, language of honeybee, economic importance.

**Unit – III**

Dairy cattle – Breeds of cow and buffalo, Cross breeds of dairy cattle, milk cattle reproduction, artificial insemination. Indian scenario of milk production, Dairy products, milk processing,

**Unit – IV**

Pisciculture: Culture of major carps and exotic fishes, common fish diseases, Shrimp culture systems, diseases of prawn. Breeds of Goat and sheep, their rearing management. Life cycle and control of Rodents

**Unit – V**

Poultry –Indigenous and exotic breeds of chickens, selection of breeds, housing of birds in poultry Rearing of birds in poultry industry, diseases of poultry,

**Practical :**

2. Identification different larvae of silk worm- Using specimens / pictures
3. Life history of different silkworm types.
4. Identification and study of important cultivable and edible fishes
5. Identification and study of important cultivable and edible crustaceans
6. Estimation of quality of milk from different dairy farm units – specific gravity, fat content, pH, viscosity.
7. Identification of purity of Honey in different samples
8. Estimation of albumen and yolk quantity in the egg.
9. Virtual demonstration of endocrine glands and their influence on growth of poultry

**➤ Reference books:****➤ E- content / E-books (optional)**

**Paper Code & Title: 25ZOODSE403: Aquaculture Management and Strategies**

| Course Name | Aquaculture Management and Strategies | L | T | P | C | IM | EM | TM  |
|-------------|---------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE403                           | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Description and Purpose:****Course Learning Objective(s):****Course Learning Outcome(s):****Unit -I**

Design, construction and management practices of Finfish hatcheries

Design, construction and management practices of prawn & shrimp Hatcheries

Design and dimensions of fish and shrimp ponds

Fertilizers: Properties of chemical fertilizers, role of inorganic, organic and bio-fertilizers in aquaculture practices.

Liming: Properties of liming materials, effects of liming on pond ecosystem,

**Unit – II**

Feeding methods: Introduction, different methods of feeding, frequency of feeding, fate of nutrients in feed, water quality and feeding rates. Harvesting methods-drainable ponds, Cage & Raceway farms, Handling-Transport.

Processing & Preservation methods of fish products and Fish byproducts, Sanitation in Processing-Treatment.

**Unit – III**

Fish Diseases - Clinical symptoms, pathology and control measures of Viral, and Bacterial diseases in fin-fish

Clinical symptoms, pathology and control measures of Fungal, Protozoan & Nutritional diseases in fin-fish.

**Unit - IV**

Shrimp Diseases: Pathology, Clinical symptoms, Prevention and treatment of viral and bacterial diseases in cultured Shrimp

Pathology, Clinical symptoms, Prevention and treatment of Fungal, protozoan, and nutritional diseases in cultured Shrimp.

**Unit - V**

Fishery and Economics- Cost calculation of projects –Demand and Price analysis. Economic Feasibility of investment analysis, Cash flow analysis- Socio-economic analysis, risk and insurance–Role of banks and funding agencies

Fish exports- Marketing and Resource Management. Legal and Environmental issues

**Practicals**

1. Design and estimates of area and construction of freshwater fish/shrimp farm
2. External examination of the diseased fish-diagnostic procedure.
3. Exploration of the skin: smear
4. Exploration of the gill: smear
5. Autopsy-examination of the infected organs.
6. Maceration and squash preparation of organs for microscopical observation
7. Collection of protozoan and metazoan parasites, Spotters/slides of parasites.

8. Museum specimens of fish infected with different parasites.

**Paper Code & Title: 25ZOODSE404: Shell-Fish Culture**

|             |                    |   |   |   |   |    |    |     |
|-------------|--------------------|---|---|---|---|----|----|-----|
| Course Name | Shell-fish Culture | L | T | P | C | IM | EM | TM  |
| Course Code | 25ZOODSE404        | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Description and Purpose:****Course Learning Objective(s):****Course Learning Outcome(s):****Unit-I**

Status of crustacean farming in India and abroad. Important cultivable prawn species and their biology - *Penaeus monodon*, *P. indicus*, *P. vannamei*, *P. semisulcatus* and *Macrobrachium rosenbergii*; Important cultivable Crab species and their biology - *Scylla serrata* and *Panilurus homarus*.

**Unit-II**

Types of farming practices: Traditional, extensive, semi-intensive, intensive, superintensive and ultra-intensive.

Farming of prawn, shrimp, crab, lobster. Harvesting, handling, Culture in Cages, re-circulatory systems and rice fields.

**Unit-III**

Water quality parameters: chemical- hardness, alkalinity, Dissolved oxygen, pH, Ammonia,. Biological- phyto & zooplankton.

Supplementary feeding: dry feeds, wet feeds, role of artificial feeds; feed ingredients and nutritional quality.

**Unit-IV**

Reproductive physiology. Reproductive hormones in crustaceans. Induced maturation in *Penaeus monodon* by eye stalk ablation.

Brood stock management of *P.monodon* and *Macrobrachium rosenbergii*.

**Unit-V**

Breeding and hatchery management of *P.monodon* and *M.rosenbergii*.

Breeding and hatchery management of crabs and bivalves.

Food and feeding of larval stages of important shellfishes.

**Practicals :**

1. Identification of commercially important fresh water/Marine shellfish
2. Pathogen (Bacterial and fungal) analysis of diseased prawns
3. Eyestalk ablation technique of shrimp/prawn
4. Water analyses (pH, dissolved oxygen, alkalinity, salinity and hardness)
5. Estimation of primary productivity and chlorophyll from water sample
6. Visit to freshwater/marine prawn farms

**Paper Code & Title: 25ZOODSE405: Marine Bioactive Compounds**

| Course Name | Marine Bioactive compounds | L | T | P | C | IM | EM | TM  |
|-------------|----------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE405                | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Description and Purpose:****Unit-I**

Introduction: Significance of marine natural products. Marine organisms having potential bioactive compounds – Corals, marine microorganisms, marine plants, marine toxins as drugs, Fish and shell fish. Isolation techniques: liquid-liquid extraction, membrane separation methods, Chromatography (paper, TLC, HPLC) techniques.

**Unit-II**

Characterisation techniques: IR, UV, NMR and Massspectra Types of important products: Antibiotic, anti-tumour, tumour-promotor, anti-inflammatory, analgesic, cytotoxic, anti-viral anti-fouling compounds of marine origin.

**Unit-III**

Marine toxins: Saxitoxin, brevitoxin and ciguatoxin Marine peptides & alkaloids: pyridoacridine, pyrrolocridine indole, pyrrole, isoquinoline alkaloids.

**Unit-IV**

Marine prostaglandins and marine cosmetic products.  
Theories of drug action and factors affecting drug action.

**Unit-V**

Seaweeds as dietary supplements, Seaweeds as sources of bioactive compounds – antioxidant, anti-bacterial and anti-viral activities, Industrial applications of seaweeds – agriculture, aqua culture feed, anti-fouling agents, biosorption of heavy metals. Seaweed hydrocolloids – Agar, alginate, carrageenan – structure, extraction, properties and biological activity

**Practicals :**

1. Separation of amino acids by paper chromatography
2. Identification of amino acids by paper chromatography
3. Preparation of crude extract by methanol: hexane solvent from molluscs, sponges, mangrove plants
4. Separation of crude extract fractions by column chromatography
4. Separation of fractions/compounds by TLC
5. Testing of Anti-bacterial activity by crude extract
6. Bioautography testing

**References:**

1. David HA et al Marine Biotechnology Plenum
2. Scheur PJ Marine Natural Products Academic
3. DS Bhakuni DS Rawat Bioactive marine natural products Springer& Anamaya
4. Chemistry of marine natural products. Paul J Scheuer, 1973. Academic Press. 2.
5. Handbook of Marine natural products. Fatturoso, Ernesto, Gerwick, William H, TagliatelaScafati, Orazio (Eds.) 2012. Springer.
6. Bioactive marine natural products. Bhakuni, Dewari S and Rawat P.S . 2005.
7. Handbook of Marine Biotechnology, S K Kim, 2015. Springer.
8. Marine products for health care. Functional and Bioactive nutraceutical compounds from the ocean. Vazhiyil Venugopal. CRC Press. 2009.

**Paper Code & Title: 25ZOODSE406: Sea Food Processing**

| Course Name | Sea Food Processing | L | T | P | C | IM | EM | TM  |
|-------------|---------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOODSE406         | 4 | 0 | 0 | 4 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Course Learning Objective(s):**

- To make students to understand
- Able to be aware of Feed, Breed Management on production and quality Get through Pre and Post slaughter handling techniques
- Capable of detailed understanding the detailed process flow of value added products from marine species
- Explain about the waste product utilization in fish industries.
- Assess the process technologies for different fish by-products

**Course Learning Outcome(s):****Unit-I**

Handling of fish onboard fishing vessels, Unit operations, unloading fish. Post-harvest fishery Losses, Methods to reduce losses. Handling fish in Landing Centers- Defects, and modification needed. Chill storage of fish:, , physical, chemical and sensory changes during chill storage, , cold shock. Different types of ice and their manufacture.

**Unit-II**

Post-mortem changes in fish. Handling and transportation of fish. Bacteriology of fish, Shellfish Handling and primary processing ; Chilling of fish, Freezing and Individual quick freezing, Heat processing of Fish; Radiation processing of fish and fish products. Drying – Traditional chimney kiln, modern mechanical fish smoking kiln of fish. Overview on – Crabs, Lobsters, Prawns, Shrimps.

**Unit-III**

Important bacterial pathogens in foods- gas producing bacteria, spore formers, aerobes, facultative aerobes, coliforms, faecal coliforms, enteric pathogens. Pathogenic viruses, food borne protozoan parasites, yeasts and molds. New pathogens and emerging food borne diseases.

**Unit-IV**

Microbial detection and indicator organisms- Quantitative methods for microbial enumeration in foods, qualitative methods to isolate microorganisms in foods, rapid methods, molecular typing methods, bioluminescence methods and biosensor for pathogen detection. Pathogen indicators- coliforms, enterobacteriaceae, bacteriophage

**Unit-V**

Introduction to seaweeds, Chemical composition; Saccharification of seaweeds; Lactic Acid fermentation of sea weeds; Applications of fermented products in food; Future prospects of seaweed fermentation.

**Practical's**

1. Wet sterilization, dry sterilization
2. Sampling of fish for aerobic plate count
3. Isolation of bacterial cultures form TPC plactes
4. Most probable number method for total coliforms, faecal coliforms & E.coli
5. Staining of bacteria
6. Identification of the bacterial cultures

7. Confirmation of E.coli
8. Detection of Salmonella, and Vibrio cholerae

**Reference Books:**

1. Venugopal, V. "Seafood Processing: Adding Value through Quick Freezing, Retort able Packaging and Cook-Chilling & other methods" (Food Science and Technology Vol. 13) , CRC press, 2006.
2. Se-Kwon Kim, "Seafood Science-Advances in chemistry, technology and its applications", CRC press, 2015. Ioannidis S Boziaris, "Seafood Processing – Technology, Quality and Safety", Wiley Blakwell, 2014.

**Paper Code & Title: 25ZOOLAB401: Evolution and Population Genetics**

| Course Name | Evolution and Population Genetics & practical component of 1 <sup>st</sup> and 3 <sup>rd</sup> selected DSE | L | T | P | C | IM | EM | TM  |
|-------------|-------------------------------------------------------------------------------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOOL401                                                                                                   | 0 | 0 | 6 | 3 | 30 | 70 | 100 |

**L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks**

**Paper Code & Title: 25ZOOSEC401: Fish economics**

|             |                |   |   |   |   |    |    |     |
|-------------|----------------|---|---|---|---|----|----|-----|
| Course Name | Fish economics | L | T | P | C | IM | EM | TM  |
| Course Code | 25ZOOSEC401    | 0 | 0 | 6 | 3 | 30 | 70 | 100 |

**L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks**

Fish economics

**Unit-I**

Introduction to fisheries economics, basic economic terminologies – micro and macro-economics, positive and normative economics, environmental economics, resource, scarcity, farm-firm relationships, production etc.

**Unit-II**

Micro-economics: theories of demand, supply; market – equilibrium price, consumption, utility, consumer's surplus. Elasticity – price, income, cross, application of elasticity in fisheries managerial decision. Farm production economics – production functions in capture and culture fisheries; Costs and returns – breakeven analysis of fish production system; concepts of externalities and social cost; factors of production, marginal cost and return, law of diminishing marginal return, returns to scale, economies of scale and scope, revenue, profit maximization, measurement of technological change, farm planning and budgeting.

**Unit-III**

Macro-economics: Introduction to national income, accounting, measurement and determinants of national income, contribution of fisheries to GNP and employment; balance of payments, economic growth and sustainable development. Globalisation: dimensions and driving Forces.

**Unit-IV**

Introduction to GATT and WTO. WTO Framework – Key Subjects - Agreement on Sanitary and Phytosanitary Measures (SPS), Seafood Export Regulations; Non-Tariff Barriers (NTBs) and Agreement on Anti-Dumping Procedures. Fisheries Subsidies and WTO. Fisheries Trade and Environment; protests against globalisation and WTO.

**Unit-V**

Intellectual Property Rights (IPR) and different forms. Patents and patenting process, Agreement on TRIPS. Bio-piracy. GMOs in fisheries. Salient features of Indian Patent (Amendment) Act 2005. Overview of Patents in Indian fisheries sector.

**Paper Code & Title: 25ZOOSEC402: Oceanography**

|             |              |   |   |   |   |    |    |     |
|-------------|--------------|---|---|---|---|----|----|-----|
| Course Name | Oceanography | L | T | P | C | IM | EM | TM  |
| Course Code | 25ZOOSEC402  | 0 | 0 | 6 | 3 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Unit-1**

The earth and the ocean basin, distribution of water and land; relief of sea floor; Major feature of Topography and Terminology; Major Divisions: Continental margin, Ocean basin floor, Mid ocean ridge system, Deep sea trenches and deeps, Relief in Indian oceans.

**Unit-II**

Ocean Waves: Definition and terms; classification Difference between surface and long waves; wave theories; surface wave generation; spreading growth; Beaufort Scale; spilling and breaking waves; long waves, Tsunamis, Seiches, internal waves. Ocean Tides: Definition; Tidal phenomenon, elementary tidal definition; tidal inequalities; tide producing forces types of tides tidal bores, tide prediction.

**Unit-III**

Ocean Currents: Definitions and features; measurements of currents; direct and indirect methods forces acting on sea waters; drift currents Ekman spirals, upwelling, sinking, gradient currents; thermohaline circulation; characteristics; course; and significance of some major ocean currents of the world. El-Nino.

**Unit-IV**

Physical properties of sea water: Salinity and chlorinity; temperature; thermal properties of sea water; colligative and other properties of sea water; properties of sea ice; transmission of sound. Concept of SONAR channel and shadow zone. Color of the sea. General distribution of temperature, salinity and density: Salinity and temperature of surface layer (SST), subsurface; distribution of temperature and salinity; The T-S diagram; water masses of Indian oceans.

**Unit-V**

Chemistry of sea water: Constancy of composition; elements present in sea water; artificial sea water; dissolves gases in sea water; CO<sub>2</sub> system and alkalinity; inorganic agencies affecting composition of sea water distribution of phosphorus, nitrogen compounds, silicates and manganese in the oceans, factor influencing their distribution

**Paper Code & Title: 25ZOOSEC403: Pollution and Coastal Zone Management**

| Course Name | POLLUTION AND COASTAL ZONE MANAGEMENT | L | T | P | C | IM | EM | TM  |
|-------------|---------------------------------------|---|---|---|---|----|----|-----|
| Course Code | 25ZOOSEC40                            | 0 | 0 | 6 | 3 | 30 | 70 | 100 |

L-Lecture, T-Tutorial, P-Practical, C-Credits, IM-Internal Marks, EM-External Marks, TM-Total Marks

**Unit-I**

Classification of pollution- physical, chemical and biological classification of water pollution description of terminologies. Sewage and domestic wastes- composition and pollution effects- sewage treatment and its reuse. Agricultural wastes- organic detritus, nutrients, Adverse effects of oxygen demanding wastes: importance of dissolved oxygen; Oxygen demand; BOD; COD; Oxygen budget; Biological effects of organic matter.

**Unit-II**

Excessive plant nutrients: Eutrophication; Red tides and fish kills. Pesticide types and categories; inorganic pesticides, Organo-chlorine compounds, Organo-phosphorous compounds; Polychlorinated biphenyls (PCBs); Bioaccumulation and impact on aquatic fauna and human health; toxicology. Heavy metals: Interaction of heavy metals with water and aquatic organisms. Bioremediation and Phytoremediation. Oil pollution; Crude oil and its fractions; Sources of oil pollution; Treatment of oil spills at sea; Beach Cleaning; Toxicity of Petroleum Hydrocarbons; Ecological Impact of Oil pollution- Case studies.

**Unit-III**

Microbial pollution: Types of aquatic microbes; autotrophs and heterotrophs; saprotrophs and necrotrophs; Sewage Fungus Complex; Transmission of Human Pathogenic Organisms; Zoonosis; Development of Antibiotic Resistance and its impact; The Coliformes Tests; Biofilms and Biocorrosion; Radioactivity and background radiation of earth: Radionuclide polluting, special effects of radioactive pollution. Thermal pollution and its effects, Physical and chemical nature of possible effluents from major industries in India.

**Unit-IV**

Monitoring and control of pollution: Biological indicators of pollution. Environmental Impact Assessment for fisheries and aquaculture projects. Functions and working of pollution control boards. Coastal zone-definition, importance. Anthropogenic activities and their impact on coastal zones; agriculture, aquaculture, waste disposal, property and infrastructure development, ports and shipping, tourism (beach and coral reef), industries (petroleum industry, heavy industry, forest industry), mining and marine excavations, water supply projects. Goals and purposes of CZM.

**Unit-V**

Management methods and information: public awareness and environment policy, general coastal zone programs, shore lands management, coastal water basin protection, coastal water quality protection, harvestable resources, and ecosystem restoration. Coastal Regulation Zone (CRZ) Act, Environment impact assessment (EIA). Integrated Coastal Zone Management (ICZM). International treaties and conventions. Preparation of projects based on the provided Guidelines and Standards for Coastal Projects- aquaculture. Power plants, disasters, etc.