



SOPHIA COLLEGE, (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

**Programme: Zoology**

**Programme Code: US.ZOO**

S.Y.B.Sc. Zoology

(Choice Based Credit System with effect from the year 2018-19)

**Programme Outline: SYBSc Zoology (SEMESTER III)**

| Course Code | Unit No | Name of the Unit   | Credits |
|-------------|---------|--|---------|
|             |         | FUNDAMENTALS OF GENETICS, CHROMOSOMES AND HEREDITY, NUCLEIC ACIDS  | 2       |
| US.ZOO.3.01 | 1       | Fundamentals of Genetics   |         |
|             | 2       | Chromosomes & Heredity   |         |
|             | 3       | Nucleic Acids  |         |
|             |         |  |         |
| US.ZOO.3.02 |         | STUDY OF NUTRITION, EXCRETION, RESPIRATION, CIRCULATION, CONTROL AND COORDINATION, LOCOMOTION AND REPRODUCTION | 2       |
|             | 1       | Nutrition & Excretion  |         |
|             | 2       | Respiration & Circulation  |         |
|             | 3       | Control and Coordination of Life Processes, Locomotion & Reproduction  |         |
| US.ZOO.3.03 |         | ETHOLOGY, PARASITOLOGY, ECONOMIC   | 2       |
|             | 1       | Ethology   |         |
|             | 2       | Parasitology   |         |
|             | 3       | Economic Zoology   |         |
| US.ZOO.P3   |         | Practical I  | 3       |
|             |         | Practical II   |         |
|             |         | Practical III  |         |

### Programme Outline: SYBSc Zoology (SEMESTER IV)

| Course Code | Unit No | Name of the Unit  | Credits |
|-------------|---------|---|---------|
| US.ZOO.4.01 |         | ORIGIN AND EVOLUTION OF LIFE, POPULATION GENETICS AND EVOLUTION, SCIENTIFIC ATTITUDE, METHODOLOGY, SCIENTIFIC WRITING AND ETHICS IN SCIENTIFIC RESEARCH | 2       |
|             | 1       | Origin and Evolution of Life  |         |
|             | 2       | Population Genetics and Evolution   |         |
|             | 3       | Scientific Attitude, Methodology, Scientific Writing and Ethics in Scientific Research  |         |
| US.ZOO.4.02 |         | CELL BIOLOGY, ENDOMEMBRANE SYSTEM AND BIOMOLECULES  | 2       |
|             | 1       | Cell Biology  |         |
|             | 2       | Endomembrane System   |         |
|             | 3       | Biomolecules  |         |
| US.ZOO.4.03 |         | COMPARATIVE EMBRYOLOGY, ASPECTS OF HUMAN REPRODUCTION, POLLUTION AND ITS EFFECT ON ORGANISMS  | 2       |
|             | 1       | Comparative Embryology  |         |
|             | 2       | Aspects of Human Reproduction   |         |
|             | 3       | Pollution and its Effect on Organisms   |         |
| US.ZOOP.4   |         | Practical I   | 3       |
|             |         | Practical II  |         |
|             |         | Practical III   |         |

## Preamble:

This syllabus of Zoology Program offered by Sophia College for Women; Mumbai has been designed under the autonomous status conferred in the academic year 2018-2019.

The syllabus tries to encompass fundamental as well as applied areas such as taxonomy, developmental biology, genetics, physiology, evolution, ecology, biochemistry, as well as applied biology disciplines like biotechnology, bioinformatics, forensic science, and many others. The syllabus is planned such that the learners who are beginning their academic journey opting for the subject of Zoology will be equipped with not only the basic knowledge of the animal world but also the recent trends in the subject.

Learning of the subject would involve various innovative pedagogies such as experiential learning, problem-based learning, collaborative learning in addition to the traditional mode of learning. Besides sensitizing the learners towards environment and sustainability, the subject also offers career opportunities in a variety of fields such as conservation, research, education, and animal management. Due care would be taken to adhere to the directions as given in the UGC Circular F14-4/2006 (CPP-II) while conducting practicals involving animal types.

## PROGRAMME OBJECTIVES

|             |  |
|-------------|--|
| <b>PO 1</b> | To provide a holistic knowledge about animal biology such as taxonomy, comparative anatomy and physiology, behaviour, ecology and evolution.                         |
| <b>PO 2</b> | To develop experimental and research-oriented skills for future career in academia   |
| <b>PO 3</b> | To gain field-based knowledge through experiential learning  |
| <b>PO 4</b> | To get acquainted with the applied areas of zoology to promote employability and entrepreneurship  |
| <b>PO 5</b> | To encourage understanding about the importance of biodiversity conservation, the threats facing ecosystems and the conservation measures used to preserve wildlife. |

## PROGRAMME SPECIFIC OUTCOMES

|              |   |
|--------------|---|
| <b>PSO 1</b> | Apply the field-based and the in-class knowledge of animal biology to identify and classify the animals in their natural habitat upto class level |
|--------------|---|

|              |  |
|--------------|--|
| <b>PSO 2</b> | Identify the various types of animal behaviour, and animal interactions with the ecosystem                       |
| <b>PSO 3</b> | Conduct basic research that involves application of critical thinking and experimental skills                    |
| <b>PSO 4</b> | Get career opportunities in a variety of fields such as conservation, research, education, and animal management |

### **SEMESTER III**

|                                       |  |                          |
|---------------------------------------|--|--------------------------|
| NAME OF THE COURSE                    | SYSTEMATIC CLASSIFICATION OF INVERTEBRATES AND ECOLOGY |                          |
| CLASS                                 | SYBSc ZOOLOGY  |                          |
| COURSE CODE                           | US.ZOO.3.01  |                          |
| NUMBER OF CREDITS                     | 2  |                          |
| NUMBER OF LECTURES PER WEEK           | 3  |                          |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 45   |                          |
| EVALUATION METHOD                     | INTERNAL ASSESSMENT                                    | SEMESTER END EXAMINATION |
| TOTAL MARKS                           | 25   | 75                       |
| PASSING MARKS                         | 10   | 30                       |

#### **COURSE OBJECTIVES:**

|       |   |
|-------|---|
| CO 1. | To develop conceptual clarity of Mendelian principles of inheritance and other forms and pattern of inheritance |
| CO 2. | To familiarize the learners with the structure, types and classification of chromosomes.                        |
| CO 3. | To introduce the learner the structure of nucleic acids and the concept of central dogma of molecular biology.  |

#### **COURSE LEARNING OUTCOMES:**

|        |  |
|--------|--|
| CLO 1. | Learners will be able to apply the principles of inheritance to study heredity   |
| CLO 2. | Learners will be able to understand the structure of a chromosome and distinguish between various types of chromosomes |
| CLO 3. | Learner will understand the importance of nucleic acids as genetic material and their role in protein synthesis        |

|               |  |
|---------------|--|
| <b>UNIT 1</b> | <b>Fundamentals of Genetics (15 LECTURES)</b>  |
| 1.1           | <p>Introduction to Genetics</p> <p>1.1.1: Definition, Scope and Importance of Genetics</p> <p>1.1.2: Classical and Modern concept of Gene (Cistron, Muton, Recon)</p> <p>1.1.3: Brief explanation of the following terms: Allele, Wild type and Mutant alleles, Locus, Dominant and Recessive traits, Homozygous and Heterozygous, Genotype and Phenotype, Genome</p>  |
| 1.2           | <p>Mendelian Genetics</p> <p>1.2.1: Mendelian Genetics: Monohybrid &amp; Dihybrid Cross, Test Cross, Back Cross, Mendel's Laws of Inheritance, Mendelian Traits in Man.</p> <p>1.2.2: Exceptions to Mendelian inheritance: Incomplete dominance, Co- dominance, Lethal Genes, Epistasis - Recessive, Double recessive, Dominant and Double dominant.</p> <p>1.2.3: Pedigree Analysis-Autosomal dominant and recessive, X- linked dominant, and recessive.</p>                |
| 1.3           | <p>Multiple Alleles and Multiple Genes</p> <p>1.3.1: Concept of Multiple Alleles, Coat colour in rabbit, ABO and Rh blood group system</p> <p>1.3.2: Polygenic inheritance with reference to skin colour and eye colour in humans.</p>   |
| 1.4           | <p>Linkage and Crossing Over</p> <p>1.4.1: Morgan's data on linkage in <i>Drosophila</i></p> <p>1.4.2: Crossing over: Process of crossing over , cytological basis of crossing over, types of crossing over</p>  |
| <b>UNIT 2</b> | <b>Chromosomes and Heredity (15 LECTURES)</b>  |
| 2.1           | <p>Chromosomes</p> <p>2.1.1: Types of chromosomes– Autosomes and Sex chromosomes</p> <p>2.1.2: Chromosome structure, Heterochromatin, Euchromatin</p> <p>2.1.3: Classification based on the position of centromere</p> <p>2.1.4: Giant chromosomes- Endomitosis, Polytene and Lampbrush chromosomes and significance of Balbiani rings.</p>  |
| 2.2           | <p>Sex- determination</p> <p>2.2.1: Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZO, ZZ-ZW.</p> <p>2.2.2: Sex determination in <i>Drosophila</i> - Genic balance theory, intersex, gynandromorphs.</p> <p>2.2.3: Sex determination in honey bees - Haplodiploidy,</p> <p>2.2.4: Hormonal influence on sex determination-Freemartin and sex reversal</p> <p>2.2.5: Role of environmental factors- <i>Bonellia</i> and Crocodile</p> <p>2.2.6: Barr bodies and Lyon hypothesis</p> |
| 2.3           | <p>Sex linked, sex influenced and sex-limited inheritance.</p> <p>2.3.1: X-Linked: Colourblindness, Haemophilia</p> <p>2.3.2: Y-linked: Hypertrichosis</p> <p>2.3.3: Sex-influenced inheritance</p> <p>2.3.4: Sex limited inheritance</p>  |
| <b>UNIT 3</b> | <b>Nucleic acids (15 LECTURES)</b>   |

|     |   |
|-----|---|
| 3.1 | Genetic material<br>3.1.1: Griffith's transformation experiments, Avery-Macleod and McCarty, Hershey Chase experiment of Bacteriophage infection<br>3.1.2: Chemical composition and structure of nucleic acids<br>3.1.3: Double helix nature of DNA, Solenoid model of DNA<br>3.1.4: Types of DNA – A, B, Z & H forms<br>3.1.5: DNA in Prokaryotes -Chromosomal and Plasmid<br>3.1.6: Extra nuclear DNA -Mitochondria and Chloroplast<br>3.1.7: RNA as a genetic material in viruses<br>3.1.8: Types of RNA: Structure and function |
| 3.2 | Flow of genetic information in a eukaryotic cell<br>3.2.1: DNA Replication<br>3.2.2: Transcription of mRNA<br>3.2.3: Translation<br>3.2.4: Genetic code   |
| 3.3 | Gene expression and regulation<br>3.3.1: One gene-one enzyme hypothesis /one polypeptide hypothesis<br>3.3.2: Concept of Operon<br>3.3.3: Lac Operon  |

## REFERENCES:

1. Benjamin, A. P. (2012). *Genetics: A Conceptual Approach*. WH Freeman
2. Hartl, D. L., and Jones, E. W. (2017). *Genetics: Analysis of Genes and Genomes*. (9th ed.). Jones and Bartlett Publishers, Inc.
3. Leeland, H. H., Leeroy, H., Michael, L. G., Ann, E. R., Lee, M. S. (2006). *Genetics from Gene to Genome*. (3rd ed.). McGraw Hill Education
4. Monroe, W. S. (2015). *Genetics*. Pearson Education India
5. Peter J. R.. (2007). *Genetics: A Mendelian Approach*. Benjamin Cummings
6. Robert F. W., Philip W. H. (1997). *Genetics*. (3rd ed.). McGraw Hill Education
7. Russell, P. J., and Gordey, K. (2016). *iGenetics*. Pearson Education India.
8. Simmons, M. J., and Snustad, D. P. (2006). *Principles of Genetics*. (8th ed.). John Wiley and Sons.
9. Verma, P.S., and Agarwal, V. K. (2022). *Cell Biology Genetics, Molecular Biology Evolution and Ecology*. (9th ed.). S. Chand Publication, New Delhi



|                                       |   |                          |
|---------------------------------------|---|--------------------------|
| NAME OF THE COURSE                    | NUTRITION AND EXCRETION,<br>RESPIRATION AND CIRCULATION,<br>CONTROL AND COORDINATION OF<br>LIFE PROCESSES, LOCOMOTION AND<br>REPRODUCTION |                          |
| CLASS                                 | SYBSc ZOOLOGY   |                          |
| COURSE CODE                           | US.ZOO.3.02   |                          |
| NUMBER OF CREDITS                     | 2   |                          |
| NUMBER OF LECTURES PER WEEK           | 3   |                          |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 45  |                          |
| EVALUATION METHOD                     | INTERNAL ASSESSMENT   | SEMESTER END EXAMINATION |
| TOTAL MARKS                           | 25  | 75                       |
| PASSING MARKS                         | 10  | 30                       |

### **COURSE OBJECTIVES:**

|       |  |
|-------|--|
| CO 1. | To introduce the concepts of physiology of nutrition, excretion and osmoregulation.                  |
| CO 2. | To introduce the concepts of physiology of respiration and circulation                               |
| CO 3. | To introduce the concepts of physiology of control and coordination and locomotion and reproduction. |

### **COURSE LEARNING OUTCOMES:**

|        |  |
|--------|--|
| CLO 1. | Learner would be able to correlate the nutritional, excretory and osmoregulatory structures as per the habits and habitat of various organisms |
| CLO 2. | Learner would be able to evaluate the increasing complexity of respiratory and circulatory physiology in evolutionary hierarchy.               |
| CLO 3. | Learner would be able to list the events involved in the process of control and coordination by nervous and endocrine regulation.              |

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|---------------|---|
| <b>UNIT 1</b> | <b>Nutrition and Excretion (15 LECTURES)</b>  |
| 1.1           | Comparative study of nutritional apparatus (structure and function): Amoeba, Hydra, Cockroach, Amphioxus, Pigeon, Ruminants.  |
| 1.2           | Physiology of digestion in man.   |
| 1.3           | Comparative study of excretory and osmoregulatory structures and functions.<br>a) Amoeba - Contractile vacuoles<br>b) Planaria - Flame cells<br>c) Cockroach - Malpighian tubules   |
| 1.4           | Categorization of animals based on principle nitrogenous excretory products   |
| 1.5           | Structure of kidney, uriniferous tubule and physiology of urine formation in man  |
| <b>UNIT 2</b> | <b>Respiration and Circulation (15 LECTURES)</b>  |
| 2.1           | Comparative study of respiratory organs (structure and function): Earthworm, Spider, Any bony fish (Rohu/ <i>Anabas/Clarius</i> ), Frog and Pigeon.   |
| 2.2           | Structure of lungs and physiology of respiration in man   |
| 2.3           | Comparative study of circulation: (a) Open and Closed type, (b) Single and Double type.   |
| 2.4           | Types of circulating fluids- Water, Coelomic fluid, Haemolymph, Lymph and Composition of blood  |
| 2.5           | Comparative study of hearts (structure and function): Earthworm, Cockroach, Shark, Frog, Crocodile and Pigeon.  |
| 2.6           | Structure and mechanism of working of heart in man.   |
| <b>UNIT 3</b> | <b>Control and Coordination, Locomotion and Reproduction (15 LECTURES)</b>  |
| 3.1           | Control and coordination<br>3.1.1: Irritability in <i>Paramecium</i> , nerve net in <i>Hydra</i> , nerve ring and nerve cord in earthworm.<br>3.1.2: Types of neurons based on the structure and function.<br>3.1.3: Conduction of nerve impulse: Resting potential, Action potential and Refractory period<br>3.1.4: Synaptic transmission |
| 3.2           | Movement and Locomotion<br>3.2.1: Locomotory organs- structure and functions of:<br>a. Pseudopodia in <i>Amoeba</i> (Sol- Gel theory), Cilia in <i>Paramecium</i><br>b. Wings and legs in cockroach<br>c. Tube feet in starfish<br>d. Fins of fish<br>3.2.2: Structure of striated muscle fibre in human and sliding filament theory        |

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|-----|--|
| 3.3 | Reproduction<br>3.3.1: Asexual Reproduction- Fission, Fragmentation, Gemmule formation and Budding<br>3.3.2: Sexual reproduction<br>Gametogenesis<br>b. Structure of male and female gametes in human<br>c. Types of fertilization<br>d. Oviparity, Viviparity, Ovo-viviparity |
|-----|--|

## REFERENCES:

1. Dharni, P. S. (2006). *Chordate Zoology*. (1<sup>st</sup> ed.). R. Chand and Co.
2. Dharni, P. S. and Dharni, J. K. (2021). *Invertebrate Zoology*. (5<sup>th</sup> ed.). Chand and Co.
3. Kotpal, R. L. (2014). *Modern Textbook of Zoology: Invertebrates*. Rastogi Publications.
4. Miller, S. A. and Harley, J. B. (2016). *Zoology*. (10<sup>th</sup> ed.). Tata McGraw Hill.
5. Moore J. (2006). *Introduction to Vertebrates*. (2<sup>nd</sup> ed.). Cambridge University- Low Priced Edition.
6. Taylor, D.J., Stout, G.W., Green, N.P.O., Soper, R. (2005). *Biological Science*. (3<sup>rd</sup> ed.). Cambridge University Press.
7. Verma, P. S. and Jordan, E. L. (2009). *Invertebrate Zoology Volume I*. (15<sup>th</sup> ed.). S. Chand and Co.
8. Verma, P. S. and Jordan, E. L. (2013). *Vertebrate Zoology Volume I*. (14<sup>th</sup> ed.). S. Chand and Co.

|                                       |  |                          |
|---------------------------------------|--|--------------------------|
| NAME OF THE COURSE                    | ETHOLOGY , PARASITOLOGY,<br>ECONOMIC ZOOLOGY |                          |
| CLASS                                 | SYBSc ZOOLOGY                                |                          |
| COURSE CODE                           | US.ZOO.3.03                                  |                          |
| NUMBER OF CREDITS                     | 2  |                          |
| NUMBER OF LECTURES PER WEEK           | 3  |                          |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 45   |                          |
| EVALUATION METHOD                     | INTERNAL ASSESSMENT                          | SEMESTER END EXAMINATION |
| TOTAL MARKS                           | 25   | 75                       |
| PASSING MARKS                         | 10   | 30                       |

## **COURSE OBJECTIVES:**

|       |   |
|-------|---|
| CO 1. | To equip learners with a sound knowledge of how animals interact with one another and their environment.  |
| CO 2. | To acquaint the learner with the concepts of parasitism and its relationship in the environment.  |
| CO 3. | To disseminate information on economic aspects of animals like apiculture, vermiculture and dairy science for encouraging towards self-employment |

## **COURSE LEARNING OUTCOMES:**

|        |  |
|--------|--|
| CLO 1. | Learner will be able to relate different types of animal behaviour and their role in biological adaptations.                 |
| CLO 2. | Learners will be able to describe the life cycle of specific parasites, the symptoms of the disease and its treatment.       |
| CLO 3. | Learner will gain fundamental knowledge on animal husbandry which may be pursued in future for entrepreneurship as a career. |

|               |  |
|---------------|--|
| <b>UNIT 1</b> | <b>Ethology (15 LECTURES)</b>  |
| 1.1           | Introduction to Ethology:<br>1.1.1: Definition, History and Scope of Ethology<br>1.1.2: Animal behaviour : Innate and Learned behaviour<br>1.1.3: Types of learning: Habituation, Imprinting and Types of imprinting - Filial and sexual, Classical conditioning<br>1.1.4: Instrumental learning and insight learning. |
| 1.2           | Aspects of animal behaviour:<br>1.2.1: Communication in bees and ants<br>1.2.2: Mimicry and colourations<br>1.2.3: Displacement activities, Ritualization<br>1.2.4: Migration in fish, schooling behaviour<br>1.2.5: Habitat selection, territorial behaviour.   |
| 1.3           | Social behaviour:<br>1.3.1: Social behaviour in primates-Hanuman langur<br>1.3.2: Elements of socio-biology: Altruism and Kinship  |

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|---------------|--|
| <b>UNIT 2</b> | <b>Parasitology (15 LECTURES)</b>  |
| 2.1           | <p>Introduction to Parasitology and Types of Parasites</p> <p>2.1.1: Definitions: Parasitism, Host, Parasite, Vector-biological and mechanical</p> <p>2.1.2: Types of parasite: Ectoparasite, Endoparasite and their subtypes</p> <p>2.1.3: Parasitic adaptations in Ectoparasites and Endoparasites</p> <p>2.1.4: Types of host: Intermediate and definitive, reservoir</p>   |
| 2.2           | <p>Host-parasite relationship and host specificity</p> <p>Different types of host – parasite relationships, structural specificity, physiological specificity and ecological specificity</p>   |
| 2.3           | <p>Life cycle, pathogenicity, control measures and treatment</p> <p>2.3.1: <i>Entamoeba histolytica</i></p> <p>2.3.2: <i>Fasciola hepatica</i></p> <p>2.3.3: <i>Taenia solium</i></p> <p>2.3.4: <i>Wuchereria bancrofti</i></p>  |
| 2.4           | <p>Morphology, life cycle, pathogenicity, control measures and treatment</p> <p>2.4.1: Head louse (<i>Pediculus humanus capitis</i>)</p> <p>2.4.2: Mite (<i>Sarcoptes scabiei</i>)</p> <p>2.4.3: Bed bug (<i>Cimex lectularis</i>)</p>   |
| 2.5           | <p>Parasitological significance</p> <p>Zoonosis- Bird flu, Anthrax, Rabies and Toxoplasmosis</p>   |
| <b>UNIT 3</b> | <b>Economic Zoology (15 LECTURES)</b>  |
| 3.1           | <p>Apiculture</p> <p>3.1.1: Methods of bee keeping and management</p> <p>a. Introduction to different species of honey bees used in apiculture.</p> <p>b. Selection of flora and bees for apiculture.</p> <p>c. Advantages and disadvantages of traditional and modern methods of apiculture.</p> <p>d. Pests and Bee enemies- Wax moth, wasp, black ants, bee-eaters, king crow and disease control</p> <p>3.1.2: Economic importance</p> <p>a. Honey- Production, chemical composition and economic importance</p> <p>b. Bee wax- Composition and economic importance.</p> <p>c. Role of honey bee in pollination.</p> |
| 3.2           | <p>Vermiculture:</p> <p>3.2.1: Rearing methods, management and economic importance</p> <p>a. Introduction to different species of earthworms used in vermiculture.</p> <p>b. Methods of vermiculture.</p>  |

|     |   |
|-----|---|
|     | c. Maintenance and harvesting<br>d. Economic importance: advantages of vermiculture, demand for earthworms; market for vermicompost and scope for entrepreneurship.   |
| 3.3 | Dairy science<br>3.3.1: Dairy development in India<br>Role of dairy development in rural economy, employment opportunities<br>3.3.2: Dairy Processing<br>Filtration, cooling, chilling, clarification, pasteurization, freezing<br>3.3.3: Milk and milk products<br>a. Composition of milk<br>b. Types of milk: Buffalo milk, Cow milk (A1 and A2), Whole milk and toned milk<br>c. Milk products |

## **REFERENCES:**

1. Arora, M. P. (1995). *Animal Behaviour*. (2nd ed.). Himalaya Publishing House.
2. Candler, W., and Kumar, N. (1998). *India: The Dairy Revolution: The Impact of Dairy Development in India and the World Bank's Contribution*. World Bank Publications.
3. Chatterjee, K. D. (2019). *Parasitology*. (13th ed.). CBS.
4. Jawaid, A. (2010). *A Handbook on Economic Zoology*. (1st ed.). S. Chand & Co.
5. Paniker, J. C. K. (2018). *Paniker's Textbook of Medical Parasitology*. (8th ed.). Jaypee Brothers Medical Publishers.
6. Manning, A., and Dawkins, M. S. (2015). *An Introduction to Animal Behaviour*. (6th ed.). Cambridge University Press.
7. McFarland, D. (1999). *Animal Behaviour: Psychobiology, Ethology and Evolution*. (3rd ed.). Longman.
8. Morse, R. A. (1975). *Bee and Bee Keeping*. Cornell University Press London.
9. Park, Y. W., and Haenlein, G. F. (Eds.). (2013). *Milk and Dairy Products in Human Nutrition: Production, Composition and Health*. John Wiley & Sons.
10. Shukla, G. S., and Upadhyay, V. B. (2014). *Applied and Economic Zoology*. (1st ed.). Rastogi Publications.
11. Venkatasubramanian, V., Singh, A. K., and Rao, S. V. N. (2003). *Dairy Development in India: An Appraisal of Challenges and Achievements*. Concept Publishing Company.

**PRACTICAL COURSE US.ZOOP.3**  
**PRACTICAL I**

1. Extraction and detection of DNA
2. Extraction and detection of RNA
3. Mounting of Barr bodies
4. Study of polytene chromosome
5. Study of mitosis- temporary squash preparation of Onion root tip
6. Detection of blood groups and Rh factor
7. Problems in Genetics
8. a) Monohybrid/ Dihybrid Cross, b) X- linked inheritance, c) Multiple Alleles
9. Chromosome morphology: (photograph to be provided)
10. Pedigree analysis
11. Problems based on molecular biology

**PRACTICAL II**

1. Urine analysis—Normal and Abnormal constituents
2. Detection of ammonia excreted by fish from aquarium water
3. Detection of uric acid from excreta of birds
4. Study of striated and non-striated muscle fibre
5. Study of nutritional apparatus (Amoeba, Hydra, Earthworm, Pigeon and Ruminant stomach)
6. Study of respiratory structures:
  - a. Gills of bony fish and cartilaginous fish
  - b. Lungs of frog
  - c. Lungs of mammal
  - d. Accessory respiratory structure in *Anabas/ Clarius*
  - e. Air sacs of Pigeon

7. Study of locomotory organs (Amoeba, Bivalve, Cockroach, Starfish, Fish, and Bird)
8. Study of different types of heart (Cockroach, Shark, Frog, Garden lizard, Crocodile and Mammal)
9. Study of permanent slides on Reproduction: (a) Sponge gemmules
10. (b) Hydra budding (c) T.S. of mammalian testis (d) T.S. of mammalian ovary

### **PRACTICAL III**

- 1.Extraction of casein from milk and its qualitative estimation
- 2.Preparation of paneer from given milk sample
- 3.Measurement of density of milk using different samples by Lactometer
- 4.Study of Honey Bee:
  - a) Life Cycle of Honey Bee and Bee Hive
  - b) Mouthparts of Honey Bee
  - c) Legs of Honey Bee
- 5.Sting Apparatus of Honey Bee
- 6.Study of ethological aspects:
  - a) Warning colouration
  - b) Animal instinct
  - c)Imprinting
  - d)Communication in animals: Chemical signals and Sound signals
- 7.Displacement activities in animals: Courtship and mating behaviour in animals and Ritualization
- 8.Study of Protozoan parasite:



a) *Trypanosoma gambiense*

b) *Giardia intestinalis*

9. Study of Helminth parasite:

a) *Ancylostoma duodenale*

b) *Dracunculus medinensis*

10. Parasitic adaptations: Scolex and mature proglottids of Tapeworm

11. Study of Ectoparasite:

a) Leech b) Tick c) Mite

12. Project- Suggested topics on economic zoology (e.g., Apiculture/ Sericulture/ Lac culture / Vermicompost technique / Construction of artificial beehives / Animal husbandry/ Aquaculture/ Any other)

### **ASSESSMENT DETAILS:( This will be same for all the theory papers)**

**Maximum Marks allotted for each theory course per semester: 100 marks**

- (a) Internal assessment of total of twenty-five (25) marks per course per semester shall be conducted as: out of 20 marks based on the test / project and out of 5 marks based on the active participation in the class.
- (b) Semester End Examination – External Assessment (75 marks)

### **Practical Assessment (for papers with practicals)**

**Maximum Marks allotted for the entire practical course per semester: 150 marks which will be distributed into the following two examination sessions and conducted as per the given question paper pattern:**

- a) Practical I examination of fifty (50) marks shall be conducted at the end of every semester.
  - b) Practical II examination of fifty (50) marks shall be conducted at the end of every semester.
  - c) Practical III examination of fifty (50) marks shall be conducted at the end of every semester.
- The duration of the practical exam will be two and a half hour.

- The students are allowed to write the paper if the attendance for practicals is more than 75%
- To appear in the practical exam, students must bring a properly certified journal.

**PAPER PATTERN OF INTERNAL ASSESSMENT**  
**US.ZOO.3.01, US.ZOO.3.02, US.ZOO.3.03**

**All Questions are compulsory**  
**Figures to the right indicate full marks**

**Time: 50 minutes**

**Total marks: 20**

|      |  |          |
|------|--|----------|
| Q.1. | Objective type questions                       | 05 marks |
| Q.2. | Answer in one sentence OR Define the following | 05 marks |
| Q.3. | Answer any two out of three (05 marks each)    | 10 marks |

**PAPER PATTERN OF THEORY EXTERNAL ASSESSMENT**  
**US.ZOO.3.01, US.ZOO.3.02, US.ZOO.3.03**

**All Questions are compulsory**  
**Figures to the right indicate full marks**  
**Time: 2.5 hours**

**Total marks: 75**

|      |  |          |
|------|--|----------|
| Q.1. | Based on UNIT 1<br>a. Answer any one of the two (10 marks)<br>b. Answer any two out of the four (5 marks each) | 20 marks |
| Q.2. | Based on UNIT 2<br>a. Answer any one of the two (10 marks)<br>b. Answer any two out of the four (5 marks each) | 20 marks |
| Q.3. | Based on UNIT 3<br>a. Answer any one of the two (10 marks)<br>b. Answer any two out of the four (5 marks each) | 20 marks |
| Q.4. | Based on all three units – two from each unit<br>Answer any three out of six (5 marks each)                    | 15 marks |

**PAPER PATTERN OF PRACTICAL EXAMINATION  
US. ZOOP.3**

**PRACTICAL I EXAMINATION**

**Duration : 2 hrs 30 min**

**Marks: 50**

**Major Question**

(15 marks)

Q1. Extraction and detection of DNA

OR

Q1. Extraction and detection of RNA

**Minor Question**

(07 marks)

Q2. Mounting of Barr bodies / Polytene chromosomes

OR

Q2. Study of mitosis-Temporary squash preparation of Onion root tip

OR

Q2. Detection of blood groups and Rh factor

Q3. Problems based on Genetics and Molecular biology

(Transcription /Genetic code) (01 problem each)

(10 marks)

Q4. Identification

(08 marks)

A. Chromosome morphology

B. Pedigree analysis

Q5. Viva

(05 marks)

Q.6 Journal

(05 marks)

**PRACTICAL II EXAMINATION**

**Duration : 2 hrs 30 min**

**Marks: 50**

**Major Question**

(15 marks)

Q1. Urine analysis—Normal and abnormal constituents

**Minor Question**

(10 marks)

Q2. Detection of ammonia excreted by fish in aquarium water

OR

Q2. Detection of uric acid from excreta of Birds

OR

Q2. Mounting of striated and non-striated muscle fibre

Q3. Identification

(15 marks)

a. Nutritional apparatus

b. Respiratory structures

c. Locomotory organs

- d. Study of hearts
- e. Permanent slides on reproduction

Q4. Viva (05 marks)

Q5. Journal (05 marks)

### **PRACTICAL III EXAMINATION**

**Duration : 2 hrs 30 min**

**Marks : 50**

**Major Question**

(12 marks)

Q1. Extraction of casein from milk and its qualitative detection

OR

Q1. Preparation of paneer from the given milk sample.

OR

Q1. Measurement of density of different samples of milk by lactometer

**Minor Question (Sketch and label)**

(08 marks)

Q2. Life cycle of honey bee

OR

Q2. Mouthparts of honey bee

OR

Q2. Legs of honey bee

OR

Q2. Sting apparatus of honey bee

Q3. Identify and describe as per instructions

(15 marks)

a. Ethology

b. Protozoan parasite

c. Helminth parasite

d. Ectoparasite

e. Parasitic adaptation

Q4. a) Project submission

(06 marks)

Q5. Viva based on project

(04 marks)

Q5. Journal

(05 marks)

## SEMESTER IV

|                                       |   |                          |
|---------------------------------------|---|--------------------------|
| NAME OF THE COURSE                    | ORIGIN AND EVOLUTION OF LIFE, POPULATION GENETICS AND EVOLUTION, SCIENTIFIC ATTITUDE, METHODOLOGY, SCIENTIFIC WRITING AND ETHICS IN SCIENTIFIC RESEARCH |                          |
| CLASS                                 | SYBSc ZOOLOGY   |                          |
| COURSE CODE                           | US.ZOO.4.01   |                          |
| NUMBER OF CREDITS                     | 2   |                          |
| NUMBER OF LECTURES PER WEEK           | 3   |                          |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 45  |                          |
| EVALUATION METHOD                     | INTERNAL ASSESSMENT   | SEMESTER END EXAMINATION |
| TOTAL MARKS                           | 25  | 75                       |
| PASSING MARKS                         | 10  | 30                       |

### COURSE OBJECTIVES:

|       |  |
|-------|--|
| CO 1. | To impart scientific knowledge about how life originated on our planet   |
| CO 2. | To develop an understanding of genetic variability within a population and learn as to how the change in the gene pool leads to evolution of species |
| CO 3. | To inculcate scientific temperament in the learner   |

### COURSE LEARNING OUTCOMES:

|        |   |
|--------|---|
| CLO 1. | Learners will analyse and critically view the different theories of evolution.                |
| CLO 2. | Learners will be able to distinguish between microevolution, macroevolution and megaevolution |
| CLO 3. | The learners will apply the concepts of research methodology through simple exercises         |

|               |  |
|---------------|--|
| <b>UNIT 1</b> | <b>Origin and Evolution of Life (15 LECTURES)</b>  |
| 1.1           | <p>Introduction</p> <p>1.1.1: Origin of the Universe</p> <p>1.1.2: Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory</p> <p>1.1.3: Origin of life</p> <p>1.1.4: Origin of eukaryotic cell</p>   |
| 1.2           | <p>Evidences in favour of organic evolution</p> <p>Evidences from geographical distribution, palaeontology, anatomy, embryology, physiology and genetics</p>   |
| 1.3           | <p>Theories of organic evolution</p> <p>1.3.1: Theory of Lamarck</p> <p>1.3.2: Theory of Darwin and Neo- Darwinism</p> <p>1.3.3: Mutation Theory</p> <p>1.3.4: Modern synthetic theory</p> <p>1.3.5: Weismann's Germplasm theory</p>   |
| <b>UNIT 2</b> | <b>Population Genetics and Evolution (15 LECTURES)</b>   |
| 2.1           | <p>Introduction to Population genetics</p> <p>Brief explanation of the following terms: Population, Gene pool, Allele frequency, Genotype frequency, Phenotype frequency, Microevolution</p>   |
| 2.2           | <p>Population genetics</p> <p>2.2.1: Hardy- Weinberg Law</p> <p>2.2.2: Factors that disrupt Hardy Weinberg equilibrium: Mutation, Migration (gene flow), Non-random mating (inbreeding, inbreeding depression, assortative mating(positive and negative), disassortative mating, Genetic drift (sampling error, fixation, bottleneck effect and founder effect)</p> <p>2.2.3: Natural Selection: Patterns of Natural Selection-Stabilizing selection, Directional selection (examples: peppered moth, antibiotic resistance in bacteria, pesticide resistance) and Disruptive selection</p>  |
| 2.3           | <p>Evolutionary genetics</p> <p>2.3.1: Genetic variation: Genetic basis of variation-mutations and recombination (crossing over during meiosis, independent assortment of chromosomes during meiosis and random union of gametes during fertilization)</p> <p>2.3.2: Nature of genetic variations: Genetic polymorphism, Balanced polymorphism, Mechanisms that preserve balanced polymorphism-Heterozygote advantage and frequency dependent selection,</p> <p>2.3.2: Neutral variations</p> <p>2.3.3: Geographic variation (Cline)</p> <p>2.3.4: Species concept: Biological species concept and evolutionary species concept</p> <p>2.3.5: Speciation and Isolating mechanisms: Definition and modes of speciation (allopatric, sympatric, parapatric and peripatric)</p> <p>2.3.6: Geographical isolation</p> <p>2.3.7: Reproductive isolation and its isolating mechanisms (prezygotic and postzygotic)</p> |

|               |   |
|---------------|---|
| 2.4           | <p>Macroevolution and megaevolution:</p> <p>2.4.1: Concept and Patterns of macroevolution: stasis, preadaptation /exaptation, mass extinctions, adaptive radiation and coevolution</p> <p>2.4.2: Megaevolution</p>  |
| <b>UNIT 3</b> | <b>Scientific Attitude Methodology, Scientific Writing and Ethics in Scientific Research (15 LECTURES)</b>  |
| 3.1           | <p>Process of science:</p> <p>3.1.1: A dynamic approach to investigation: The Scientific method, Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery(serendipity)</p> <p>3.1.2: Scientific research: Definition, difference between method and methodology, characteristics, types</p> <p>3.1.3: Steps in the Scientific method: Identification of research problem, formulation of research hypothesis, testing the hypothesis using experiments or surveys, preparing research/study design including methodology and execution (appropriate controls, sample size, technically sound, free from bias, repeat experiments for consistency), documentation of data, data analysis and interpretation, results and conclusions</p> <p>3.1.4: Dissemination of data: Reporting results to scientific community (publication in peer-reviewed journals, thesis, dissertation, reports, oral presentation, poster presentation)</p> <p>3.1.15: Application of knowledge: Basic research, Applied and Translational research</p> |
| 3.2           | <p>Scientific writing:</p> <p>Structure and components of a research paper: preparation of manuscript for publication of research paper- title, authors and their affiliations, abstract, keywords and abbreviations, introduction, material and methods, results, discussion, conclusions, acknowledgement, bibliography; figures, tables and their legends</p>  |
| 3.3           | <p>Writing a review paper</p> <p>3.3.1: Structure and components of review paper</p> <p>3.3.2: Report writing and types of report</p> <p>3.3.3: Computer application: Plotting of graphs, Statistical analysis of data.</p> <p>3.3.4: Internet and its application in research-Literature survey, online submission of manuscript for publication</p>   |
| 3.4           | <p>Ethics</p> <p>3.4.1: Ethics in animal research: The ethical and sensitive care and use of animals in research, teaching and testing, approval from Dissection Monitoring Committee (DMC)</p> <p>3.4.2: Ethics in clinical research: Approval from clinical research ethics committee or/and informed consent</p>   |
| 3.5           | Plagiarism  |

## REFERENCES:

1. Hartel, D. L., and Clark, A. G. (1997). *Principles of Population Genetics*. (3rd ed.). Sinauer Associates Inc. Sunderland, Massachusetts.

2. Kothari, C. R. (1990). *Research Methodology: Methods and Techniques*. (2nd ed.) New Age International Publishers.
3. Leedy, P. D. and Ormrod, J. (2018). *Practical Research Planning and Design*. (12th ed.). Pearson Publication.
4. Smith. (1958). *Theory of Evolution*. Cambridge University Press.
5. Strickberger. (1990). *Evolution*. Jones and Bartlett.
6. Verma, P. S., and Agarwal. (2009). *Evolution: Population Genetics*. Matthew B. Hamilton (9th ed.). S. Chand Publishing.

|                                       |  |                          |
|---------------------------------------|--|--------------------------|
| NAME OF THE COURSE                    | CELL BIOLOGY, ENDOMEMBRANE SYSTEM AND BIOMOLECULES |                          |
| CLASS                                 | SYBSc ZOOLOGY                                      |                          |
| COURSE CODE                           | US.ZOO.4.02  |                          |
| NUMBER OF CREDITS                     | 2  |                          |
| NUMBER OF LECTURES PER WEEK           | 3  |                          |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 45   |                          |
| EVALUATION METHOD                     | INTERNAL ASSESSMENT                                | SEMESTER END EXAMINATION |
| TOTAL MARKS                           | 25   | 75                       |
| PASSING MARKS                         | 10   | 30                       |

### **COURSE OBJECTIVES:**

|       |  |
|-------|--|
| CO 1. | To study the structural and functional organization of cell with an emphasis on nucleus, plasma membrane and cytoskeleton. |
| CO 2. | To acquaint the learner with ultrastructure of cell organelles and their functions   |
| CO 3. | To give learner insight into the structure of biomolecules and their role in sustenance of life.                           |



## COURSE LEARNING OUTCOMES:

|        |   |
|--------|---|
| CLO 1. | Learner would acquire insight into the composition of the transport mechanisms adopted by the cell and its organelles for its maintenance and composition of cell |
| CLO 2. | Learner will understand the interlinking of endomembrane system for functioning of cell   |
| CLO 3. | The learner will be able to describe the various biomolecules and their clinical significance.  |

|               |   |
|---------------|---|
| <b>UNIT 1</b> | <b>Cell Biology (15 LECTURES)</b>   |
| 1.1           | Introduction to cell biology <ul style="list-style-type: none"><li>● Definition and scope</li><li>● Cell theory</li></ul> Generalized prokaryotic, eukaryotic cell: size, shape and structure   |
| 1.2           | Nucleus <ul style="list-style-type: none"><li>● Size, shape, number and position</li><li>● Structure and functions of interphase nucleus</li><li>● Ultrastructure of nuclear membrane and pore complex</li><li>● Nucleolus: general organization, chemical composition &amp; functions</li><li>● Nuclear sap/ nuclear matrix</li></ul> Nucleocytoplasmic interactions |
| 1.3           | Plasma membrane <ul style="list-style-type: none"><li>● Fluid Mosaic Model</li><li>● Junctional complexes</li><li>● Membrane receptors</li></ul> Modifications: Microvilli and Desmosomes   |
| 1.4           | Transport across membrane <ul style="list-style-type: none"><li>● Diffusion and Osmosis</li><li>● Transport: Passive and Active</li><li>● Endocytosis and Exocytosis</li></ul>  |
| 1.5           | Cytoskeletal structures <ul style="list-style-type: none"><li>● Microtubules: Composition and functions</li><li>● Microfilaments: Composition and functions</li></ul>   |
| <b>UNIT 2</b> | <b>Endomembrane System (15 LECTURES)</b>  |
| 2.1           | Endoplasmic reticulum (ER): General morphology of endomembrane system, ultrastructure, types of ER and biogenesis of ER<br>Functions of Rough Endoplasmic Reticulum (RER) and Smooth Endoplasmic Reticulum (SER)  |

|               |  |
|---------------|--|
| 2.2           | Golgi complex: Ultrastructure of Golgi complex, functions of Golgi complex (protein glycosylation, lipid and polysaccharide metabolism, protein sorting and secretion, Golgi Anti-Apoptotic Protein -GAAP)   |
| 2.3           | Lysosomes: Origin, occurrence, polymorphism and functions;<br>Peroxisomes: Origin, morphology & functions  |
| 2.4           | Mitochondria: Ultrastructure, chemical composition, functions of mitochondria and bioenergetics (Chemical energy & ATP, Krebs's cycle, respiratory chain and oxidative phosphorylation)  |
| <b>UNIT 3</b> | <b>Biomolecules (15 LECTURES)</b>  |
| 3.1           | Biomolecules: Concept of micromolecules and macromolecules   |
| 3.2           | Carbohydrates: <ul style="list-style-type: none"> <li>● Definition classification, properties and isomerism, glycosidic bond</li> <li>● Structure of Monosaccharides (glucose and fructose); Oligo-saccharides (lactose and sucrose); Polysaccharides (cellulose, starch, glycogen and chitin)</li> </ul> Biological role and clinical significance  |
| 3.3           | Amino Acids and Proteins: <ul style="list-style-type: none"> <li>● Basic structure, classification of amino acids,</li> <li>● Essential and Non-essential amino acids, Peptide bond,</li> <li>● Protein conformation: Primary, Secondary, Tertiary, Quaternary</li> <li>● Types of proteins – Structural (collagen) and functional proteins (haemoglobin)</li> </ul> Biological role and clinical significance |
| 3.4           | Lipids: <ul style="list-style-type: none"> <li>● Definition, classification of lipids with examples, ester linkage</li> <li>● Physical and chemical properties of lipids</li> <li>● Saturated and unsaturated fatty acids</li> <li>● Essential fatty acids; Triacylglycerols; Phospholipids (lecithin and cephalin); Steroids (cholesterol)</li> </ul> Biological role and clinical significance               |
| 3.5           | Vitamins: <ul style="list-style-type: none"> <li>● Water soluble vitamins(e.g. Vit C, Vit B<sub>12</sub>)</li> <li>● Lipid soluble vitamins (e.g. Vit A, Vit D)</li> </ul> Biological role and clinical significance   |

## REFERENCES:

1. Alberts, B. and Heald, R. (2022). *Molecular Biology of the Cell*. (7th ed.). WW Norton & Co.
2. Berg, J., Gatto Jr., G., Hines, J., Tymoczko, J.L., Stryer L. (2023). *Biochemistry* (10<sup>th</sup> ed.). W. H. Freeman & Co Ltd.
3. Conn, E. E., and Stumpf, P. K. (1976). *Outline of Biochemistry*. (4th ed.). John Wiley and Sons, USA.

4. Cooper, G. M. and Hausman, R. E. (2013). *The Cell: A Molecular Approach*. (6th ed.). Sinauer Associates Inc.
5. Deb, A. C. (1983). *Fundamentals of Biochemistry*. (91st ed.). New Central Book Agency Ltd.
6. De Robertis, E.D.P., and Robertis, E.M.R. (2017). *Cell and Molecular Biology*. Lea & Febiger, U.S.
7. Gupta, P. K. (2021). *Cell and Molecular Biology*. (5th ed.). Rastogi Publication.
8. Lehninger, A. L., Nelson, D. L., and Cox, M. M. (2005). *Principles of Biochemistry*. (2nd and 3rd ed.). W. H. Freeman.
9. Murray, R. K., Granner, D. K., Mayes, P. A., and Rodwell, V. M. (1996). *Harper's Biochemistry*. (26th ed.). Hall International.
10. Pawar, C. B. (2010). *Cell Biology*. Himalaya Publishing House.
11. Rao, A. V. S. S., and Suryalakshmi, A. (2002). *A Textbook of Biochemistry*. (9th ed.). UBS Publishers' Distributors Ltd.
12. Sharma, D. K. (2010). *Biochemistry*. (1st ed.). Narosa Publishing House Pvt. Ltd.
13. Singh, S.P. and Tomar B.S. (2005). *Cell Biology*. (1<sup>st</sup> ed.). Rastogi Publication.
14. Stryer, L. (1995). *Biochemistry*. (3<sup>rd</sup> ed.). W.H. Freeman and Co., NY.
15. Zubay, G. (1983). *Biochemistry*. (1st ed.). Addison Wesley.

|                                       |   |                          |
|---------------------------------------|---|--------------------------|
| NAME OF THE COURSE                    | COMPARATIVE EMBRYOLOGY,<br>ASPECTS OF HUMAN REPRODUCTION,<br>POLLUTION AND ITS EFFECT ON<br>ORGANISMS |                          |
| CLASS                                 | SYBSc ZOOLOGY   |                          |
| COURSE CODE                           | US.ZOO.4.03   |                          |
| NUMBER OF CREDITS                     | 2   |                          |
| NUMBER OF LECTURES PER WEEK           | 3   |                          |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 45  |                          |
| EVALUATION METHOD                     | INTERNAL ASSESSMENT   | SEMESTER END EXAMINATION |
| TOTAL MARKS                           | 25  | 75                       |
| PASSING MARKS                         | 10  | 30                       |

## **COURSE OBJECTIVES:**

|       |   |
|-------|---|
| CO 1. | To acquaint the learner with key concepts of embryology   |
| CO 2. | To acquaint the learners with different aspects of human reproduction including issues related to infertility |
| CO 3. | To provide a panoramic view of impact of human activities leading to pollution and its implications.          |

## **COURSE LEARNING OUTCOMES:**

|        |   |
|--------|---|
| CLO 1. | Learner will be able to describe the various stages of development  |
| CLO 2. | Learners will be able to understand human reproductive physiology and advances in ART and related ethical issues. |
| CLO 3. | The learners will be able to relate the adverse effects of pollution and measures to control it.                  |

|               |   |
|---------------|---|
| <b>UNIT 1</b> | <b>Comparative Embryology (15 LECTURES)</b>   |
| 1.1           | Types of Egg- Based on amount and distribution of yolk  |
| 1.2           | Structure and Types of Sperm  |
| 1.3           | Types of Cleavage   |
| 1.4           | Types of Blastula   |
| 1.5           | Types of Gastrula   |
| 1.6           | Coelom -Formation and types   |
| <b>UNIT 2</b> | <b>Aspects of Human Reproduction (15 LECTURES)</b>  |
| 2.1           | Human reproductive system and hormonal regulation<br>2.1.1: Anatomy of human male and female reproductive system<br>2.1.2: Hormonal regulation of reproduction and impact of age on reproduction - menopause and andropause |
| 2.2           | Contraception & birth control<br>2.2.1: Difference between contraception and birth control<br>2.2.2: Natural Methods: Abstinence, rhythm method, temperature method, cervical   |

|               |   |
|---------------|---|
|               | <p>mucus or Billings method, coitus interruptus, lactation , amenorrhea</p> <p>2.2.3: Artificial methods : Barrier methods, hormonal methods, intrauterine contraceptives, sterilization, termination, abortion</p>   |
| 2.3           | <p>Female infertility:</p> <p>2.3.1: Causes: Failure to ovulate; production of infertile eggs; damage to oviducts (oviduct scarring and Pelvic inflammatory disease -PID, TB of oviduct), Uterus (TB of uterus and cervix)</p> <p>2.3.2: Infertility associated disorders: Endometriosis, Polycystic Ovarian Syndrome (PCOS), Primary ovarian failure(POF), Sexually Transmitted Infections (STIs) - gonorrhoea, chlamydia, syphilis and genital herpes; Antibodies to sperm; Genetic causes- recurrent abortions</p>   |
| 2.4           | <p>Treatment of infertility</p> <p>2.4.1: Removal /reduction of causative environmental factors</p> <p>2.4.2: Surgical treatment</p> <p>2.4.3: Hormonal treatment- fertility drugs</p> <p>2.4.4: Assisted Reproductive Technology (ART) -<br/><i>Invitro</i> fertilization (IVF); Embryo transfer (ET); Intra-Fallopian transfer (IFT), Gamete Intra-Fallopian Transfer (GIFT) &amp; Intra-Zygote Transfer (ZIFT); Intra-cytoplasmic Sperm Injection (ICSI) with ejaculated sperm and sperm retrieved from testicular biopsy; Testicular sperm extraction (TESE).</p> <p>2.4.5: Sperm bank, cryopreservation of gametes and embryos</p> <p>2.4.6: Surrogacy</p> |
| <b>UNIT 3</b> | <b>Pollution and its effect on organisms (15 LECTURES)</b>  |
| 3.1           | <p>Air Pollution</p> <p>3.1.1: Types and sources of air pollutant</p> <p>3.1.2: Effects of air pollution on organisms, its control and abatement measures</p>   |
| 3.2           | <p>Water Pollution</p> <p>3.2.1: Types and sources of water pollutant</p> <p>3.2.2: Effects of water pollution on organisms, its control and abatement measures</p>   |
| 3.3           | <p>Soil Pollution</p> <p>3.3.1: Types and sources of soil pollutant</p> <p>3.3.2: Effects of soil pollution on organisms, its control and abatement measures</p>  |
| 3.4           | <p>Sound pollution</p> <p>3.4.1: Different sources of sound pollution</p> <p>3.4.2: Effects of sound pollution on organisms, its control and abatement measures</p>   |
| 3.5           | Pollution by radioactive substances   |
| 3.6           | <p>Pollution by solid wastes</p> <p>3.6.1: Types and sources</p> <p>3.6.2: Effects of solid waste pollution, its control and abatement measures</p>   |
| 3.7           | Pollution leading to Climate Change and Global Warming  |

## REFERENCES:

1. Arora, M. P. (2017). *Embryology*. Himalaya Publishing House
2. Berril, N. J. (1971). *Developmental Biology*. Tata McGraw-Hill Publication.
3. Bhargava, S. K. (2008). *Practical Methods for Water and Air Pollution Monitoring*. New Age International.
4. Bhatia, S. C. (2021). *Textbook of Air Pollution and its Control*. Atlantic Publishers and Distributors (P) Ltd.
5. Chatwal, G. R., Sharma, H., and Arora, M. (1994). *A Textbook of Environmental Studies*. (1st ed.). New Age Publisher International Pvt Ltd.
6. Chiras, D. D. (2018). *Human Biology*. (9th ed.). Jones and Bartlett.
7. De, A. K. (2016). *Environmental Chemistry*. (1st ed.). New Age International.
8. Dogra, S. S. (2008). *A Textbook of Environmental Chemistry and Pollution Control*. Swastik Publishers.
9. Gilbert, S. F. (2016). *Developmental Biology*. (11th ed.). Sinauer Associates Inc.
10. Johnson, M. H. (2018). *Essential Reproduction*. (8th ed.). Wiley-Blackwell Publication.
11. Kaur, K. (2007). *Handbook of Water and Wastewater Analysis*. Atlantic.
12. Kudesia, V. P. (2017). *Air Pollution*. Pragati Prakasan, Meerut.
13. Manahan, S. E. (Year). *Environmental Science and Technology*.
14. Marieb, E. L. and Hoehn, K. (2018). *Human Anatomy and Physiology*. (11th ed.). Pearson Education.
15. Mudakavi, J. R. (2013). *Principles and Practices of Air Pollution Control and Analysis*. I. K International Pub. House Pvt. Ltd.
16. Nobil, E. K., and Neil, J. D. (2015). *The Physiology of Reproduction (Vol I & II)*. Raven Press.
17. Pattern, B. M. (Year). *Chick Embryology*.
18. Solomon, E. P., Berg, L. R., and Martin, D. W. (2011). *Biology*. (11th ed.). Thompson Brooks/Cole.
19. Subramoniam, T. (2002). *Developmental Biology*. (1st ed.). Narosa Publishers.
20. Taylor, Green, N. P. O., and Stout, G. W. (2005). *Biological Science*. (3rd ed.). Cambridge Publication.
21. Vallero, D. A. (2014). *Fundamentals of Air Pollution*. (5th Edition). Academic Press.
22. Verma, P.S. and Agarwal, V.K. (2005). *Chordate Embryology*. (25th ed.). S. Chand & Company.

## **PRACTICAL COURSE US.ZOOP.4**

|          | <b><u>PRACTICAL I</u></b>  |
|----------|--|
| <b>1</b> | Study of population density by Line transect method & Quadrant method and calculate different diversity indices. <ul style="list-style-type: none"><li>● Index of Dominance</li><li>● Index of frequency</li><li>● Rarity Index</li><li>● Shannon Index</li><li>● Index of species diversity</li></ul> |
| <b>2</b> | Study of prokaryotic cells (bacteria) by Crystal violet staining technique   |
| <b>3</b> | Study of eukaryotic cells (WBCs) from blood smear by Leishman's stain  |
| <b>4</b> | Identification and study of fossils: <ul style="list-style-type: none"><li>● Arthropods: Trilobite</li><li>● Mollusca: Ammonite</li><li>● Aves: Archaeopteryx</li></ul>  |
| <b>5</b> | Identification of <ul style="list-style-type: none"><li>● Allopatric speciation (Cyprinodont species)</li><li>● Sympatric speciation (Hawthorn fly and Apple maggot fly)</li><li>● Parapatric speciation (Snail)</li></ul>   |
| <b>6</b> | Bibliography/ Abstract writing   |
| <b>7</b> | Preparation of Power Point Presentation based on research paper.   |

|          | <b><u>PRACTICAL II</u></b>  |
|----------|---|
| <b>1</b> | Study of permeability of cell through plasma membrane (osmosis in blood cells)  |
| <b>2</b> | Measurement of cell diameter by oculometer (by using permanent slide)   |
| <b>3</b> | Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Barfoed's test, Anthrone test)   |
| <b>4</b> | Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoproteic test)  |
| <b>5</b> | Qualitative test for lipids (Solubility test, Sudan III test)   |
| <b>6</b> | Study of rancidity of lipids by titrimetric method  |
| <b>7</b> | Ultrastructure of cell organelles (Electron micrographs) of: <ul style="list-style-type: none"> <li>● Nucleus</li> <li>● Endoplasmic reticulum (Smooth and Rough)</li> <li>● Mitochondria.</li> <li>● Golgi apparatus</li> <li>● Lysosomes</li> </ul>   |
| <b>8</b> | Study of clinical disorders due to carbohydrates, proteins and lipid imbalance (Photograph to be provided / symptoms to be given and disorder to be identified): <ul style="list-style-type: none"> <li>● Hyperglycemia</li> <li>● Hypoglycemia</li> <li>● Anaemia</li> <li>● Kwashiorkor</li> <li>● Marasmus</li> <li>● Fatty liver</li> </ul> |



|           | <b>PRACTICAL III</b>   |
|-----------|--|
| <b>1</b>  | Study of air microflora  |
| <b>2</b>  | Estimation of dissolved oxygen from the given water sample   |
| <b>3</b>  | Estimation of salinity by refractometer from the given water sample  |
| <b>4</b>  | Estimation of conductivity by conductometer from the given water sample  |
| <b>5</b>  | Study of physical properties of soil: temperature, moisture and texture  |
| <b>6</b>  | Study of chemical properties of soil- pH, organic matter   |
| <b>7</b>  | Study of sound pollution monitoring device   |
| <b>8</b>  | Detection of pregnancy from given sample of urine  |
| <b>9</b>  | Study of birth control measures applicable to humans – IUD, condom and hormonal pills  |
| <b>10</b> | Study of the following permanent slides, museum specimens and materials<br>a. Mammalian sperm and ovum<br>b. Types of egg –fish, frog and hen<br>c. Cleavage, blastula and gastrula (Amphioxus, Frog and Bird) |
| <b>11</b> | Review writing based on programmes telecast by Doordarshan, Gyandarshan, UGC programmes or other media sources   |
| <b>12</b> | Study of natural ecosystem and field report of the visit   |

### **ASSESSMENT DETAILS: (this will be same for all the theory papers)**

**Maximum Marks allotted for each theory course per semester: 100 marks**

#### **Internal Assessment (25 marks)**

- Internal assessment of total of twenty five (25) marks per course per semester shall be conducted as: out of 20 marks based on the test / project and out of 5 marks based on the active participation in the class.
- Semester End Examination – External Assessment (75 marks)

## **Practical Assessment (for papers with practicals)**

**Maximum Marks allotted for the entire practical course per semester: 150 marks which will be distributed into the following two examination sessions and conducted as per the given question paper pattern:**

- a) Practical I examination of fifty (50) marks shall be conducted at the end of every semester.
- b) Practical II examination of fifty (50) marks shall be conducted at the end of every semester.
- c) Practical III examination of fifty (50) marks shall be conducted at the end of every semester.
- The duration of the practical exam will be two and a half hours.
- The students are allowed to write the paper if the attendance for practicals is more than 45%
- To appear in the practical exam, students must bring a properly certified journal.

### **PAPER PATTERN OF INTERNAL ASSESSMENT**

**US.ZOO.4.01 , US.ZOO.4.02, US.ZOO.4.03**

**All Questions are compulsory**

**Figures to the right indicate full marks**

**Time: 50 minutes**

**Total marks: 20**

|      |  |          |
|------|--|----------|
| Q.1. | Objective type questions                       | 05 marks |
| Q.2. | Answer in one sentence OR Define the following | 05 marks |
| Q.3. | Answer any two out of three (05 marks each)    | 10 marks |

### **PAPER PATTERN OF THEORY EXTERNAL ASSESSMENT**

**US.ZOO.4.01 , US.ZOO.4.02, US.ZOO.4.03**

**All Questions are compulsory**

**Figures to the right indicate full marks**

**Time: 2.5 hours**

**Total marks: 75**

|      |  |          |
|------|--|----------|
| Q.1. | Based on UNIT 1<br>a. Answer any one of the two (10 marks)<br>b. Answer any two out of the four (5 marks each) | 20 marks |
| Q.2. | Based on UNIT 2<br>a. Answer any one of the two (10 marks)<br>b. Answer any two out of the four (5 marks each) | 20 marks |
| Q.3. | Based on UNIT 3<br>a. Answer any one of the two (10 marks)<br>b. Answer any two out of the four (5 marks each) | 20 marks |
| Q.4. | Based on all three units – two from each unit<br>Answer any three out of six (5 marks each)                    | 15 marks |

## **PAPER PATTERN OF PRACTICAL EXAMINATION**

### **US. ZOOP.4**

#### **PRACTICAL I EXAMINATION**

**Time: 2 hrs 30 min**

**Marks: 50**

**Major Question**

**(12 marks)**

Q1. Study Population density by Line transect or Quadrant method and calculate Biodiversity Indices. (Any 2)

**Minor Question**

**(08 marks)**

Q2. Prepare a smear to show prokaryotic cell.

OR

Q2. Prepare a smear to show eukaryotic cell.

Q3. Identify and describe as per instructions

**(08 marks)**

a) Fossil b) Speciation

Q4. From the given article, prepare the bibliography/ abstract.

**(06 marks)**

Q5. Submission of Power point presentation.

**(06 marks)**

Q6. Viva.

**(05 marks)**

Q7. Journal.

**(05 marks)**

#### **PRACTICAL II EXAMINATION**

**Time: 2 hrs 30 min**

**Marks: 50**

**Major Question**

**(15 marks)**

Q1. Study of osmosis in RBCs.

OR

Q1. Measurement of cell diameter by occulometer using permanent slide.

**Minor Question**

**(10 marks)**

Q2. Qualitative tests for carbohydrates (Molisch's test, Benedicts test, Fehling's test, Anthrone test)

OR

Q2. Qualitative tests for protein (Ninhydrin test, Biuret test, Millon's test, Xanthoprotein test)  
OR

Q2. Qualitative test for lipid (Solubility test, Sudan III test)  
OR

Q2. Estimation of rancidity of lipids by titrimetric method

Q3. Identify and describe as per instructions (15 marks)  
• Ultrastructure of cell organelles (a, b & c)  
• Clinical disorders (d & e)

Q4. Viva (05 marks)

Q5. Journal (05 marks)

### **PRACTICAL III EXAMINATION**

**Time: 2 hrs 30 min**

**Marks: 50**

#### **Major Question**

(12 marks)

Q1. Estimation of Dissolved Oxygen from the given water sample.  
OR

Q1. Detection of pregnancy from given sample of urine.  
OR

Q1. Determination of organic matter from the given soil sample.

#### **Minor Question**

(08 marks)

Q2. Estimation of salinity by refractometer from the given water sample.  
OR

Q2. Estimation of conductivity by conductometer from the given water sample.  
OR

Q2. Determination the pH of the given soil sample.  
OR

Q2. Determine the texture of the given soil sample.

Q3. Identify and describe as per instructions (15 marks)  
• Permanent slides on embryology (a & b)  
• Birth control measure (c)  
• Fishery (d & e)

Q4. a) Field report submission (06 marks)  
b) Viva based on field report (04 marks)

Q5. Journal (05 marks)