# I Semester BSc Zoology
# Core Course Content

| | |
|---|---|
| Course Title/Code: **Cytology, Genetics and Infectious Diseases** | Course Credits: **4** |
| Course Code: **DSCC5Z00T1** | L-T-P per week: 4-0-0 |
| Total Contact Hours**: 56** | Duration of ESA: 3 Hours |
| Formative Assessment Marks: **40** | Summative Assessment Marks:**60** |
| Model Syllabus Authors: | |

**Core Course prerequisite:** To study Zoology in undergraduate, student must have studied Biology or equivalent subject in Class 12.

**Course Outcomes (COs):**

At the end of the course the student should be able to understand:

1. The structure and function of the cell organelles.
2. The chromatin structure and its location.
3. The basic principle of life, how a cell divides leading to the growth of an
4. Organism and also reproduces to form a new organism.
5. How a cell communicates with its neighboring cells?
6. The principles of inheritance, Mendel 's laws and the deviations.
7. How environment plays an important role by interacting with genetic factors.
8. Detect chromosomal aberrations in humans and study of pedigree analysis.

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)**

| **Course Outcomes (COs) / Program Outcomes (POs)** | **CC T1** | **CC 2** | **CC 3** | **CC 4** | **CC 5** | **CC 6** | **CC 7** | **CC 8** | **CC 9** | **CC 10** | **CC 11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I Core competency | X | | | | | | | | | | |
| II Critical thinking | X | | | | | | | | | | |
| III Analytical reasoning | X | | | | | | | | | | |
| IV Research skills | X | | | | | | | | | | |
| V Team work | X | | | | | | | | | | |

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark =X 'in the intersection cell if a course outcome addresses a particular program outcome.

**Semester I- Zoology**
**Core Course I Content:**

| **Content** | **Hours** |
|---|---|
| **Unit** | **14** |
| **Chapter 1. Ultra** structure and Function of Cell Organelles I in Animal Cell<br>• Plasma membrane: Chemical composition—Fluid mosaic model<br>• Endomembrane system: protein targeting and sorting, transport, endocytosis and exocytosis, types of cell junctions | |

| | |
|---|---|
| **Chapter 2. Structure and Function of Cell Organelles II in Animal Cell**<br>• Cytoskeleton: microtubules, microfilaments, intermediate filaments<br>• Mitochondria: Structure, oxidative phosphorylation; electron transport system. Endoplasmic reticulum: Structure, and function.<br>• Peroxisome and Ribosome: structure and function | |
| **Unit II** | **14** |
| **Chapter 3. Nucleus and Chromatin Structure**<br>• Structure and function of nucleus in eukaryotes<br>• Chemical structure and base composition of DNA and RNA<br>• Ultra structure of eukaryotic chromosome, Chromatin Organization-Nucleosome model<br>• Types of DNA and RNA | |
| **Chapter 4. Cell cycle, Cell Division and Cell Signaling**<br>• Cell division: mitosis and meiosis<br>• Introduction to Cell cycle and its regulation, apoptosis<br>• Signal transduction: intracellular signaling and cell surface receptors, via G-protein linked receptors.<br>• Cell-cell interaction: -autocrine, paracrine and endocrine types. | |
| **Unit III** | **14** |
| **Chapter 5. Mendelism and Sex Determination**<br>• Basic principles of heredity: Mendel 's laws- monohybrid cross and dihybrid cross<br>• Incomplete Dominance<br>• Genetic Sex-Determining Systems, Environmental Sex Determination,<br>• Chromosomal Sex Determination and mechanism in *Drosophila melanogaster.*<br>• Sex-linked characteristics in humans and dosage compensation. | |
| **Chapter 6. Extensions of Mendelism, Genes and Environment**<br>• Extensions of Mendelism: Multiple Alleles, Gene Interaction-inheritance of comb pattern in fowl.<br>• The Interaction Between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics<br>• Cytoplasmic Inheritance- Kappa particles in Paramecium, Genetic Maternal Effects.<br>• Interaction between Genes and Environment.<br>• Inheritance of Continuous Characteristics. | |
| **Unit IV** | **14** |
| **Chapter 7. Human Chromosomes and Patterns of Inheritance**<br>• Patterns of inheritance: autosomal dominance, autosomal recessive, X-linked recessive, X-linked dominant.<br>• Chromosomal anomalies: Structural and numerical aberrations with examples.<br>• Human karyotyping and Pedigree analysis. | |
| **Chapter 8. Infectious Diseases**<br>• Introduction to human pathogenic organisms- viruses, bacteria, fungi, protozoa and helminths worms.<br>• Structure, life cycle, pathogenicity, including diseases, causes, symptoms and control of common parasites: *Trypanosoma, Giardia and Wuchereria.* | |

## Suggested Readings:


1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Lewin B. Genes VIII. Pearson (2004).
6. Watson et al. Molecular Biology of the Gene. Pearson (2004).
7. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby- Kuby Immunology. W H Freeman (2007).
8. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell (2017).
9. Principles of Genetics by B. D. Singh
10. Cell-Biology by C. B. Pawar, Kalyani Publications
11. Economic Zoology by Shukla and Upadhyaya

**Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar**

| **Formative Assessment** | |
|---|---|
| **Assessment Occasion** | **Weightage in** |
| **House Examination/Test** | 20 |
| **Written Assignment/Presentation/Project / Term** | 15 |
| **Class performance/Participation** | 05 |
| **Total** | **40** |

## Zoology Core Lab Course Content

**Semester I**

| Course Title: Cell Biology &Cytogenetics Lab | Course Credits:**2** |
|---|---|
| Course Code: **DSCC5Z00P1** | L-T-P per week: 0-0-4 |
| Total Contact Hours**: 56** | Duration of ESA: 4 Hours |
| Formative Assessment Marks: **25** | Summative Assessment Marks:**25** |
| Model Syllabus Authors: | |

**Course Outcomes (COs):**

At the end of the course the student should be able to:

1. To use simple and compound microscopes.
2. To prepare stained slides to observe the cell organelles.
3. To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
4. The chromosomal aberrations by preparing karyotypes.
5. How chromosomal aberrations are inherited in humans by pedigree analysis in families. The antigen-antibody reaction.

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)**

| **Course Outcomes (COs) / Program Outcomes (POs)** | **CC P1** | **CC 2** | **CC 3** | **CC 4** | **CC 5** | **CC 6** | **CC 7** | **CC 8** | **CC 9** | **CC 10** | **CC 11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I Core competency | X | | | | | | | | | | |
| II Critical thinking | X | | | | | | | | | | |
| III Analytical reasoning | X | | | | | | | | | | |
| IV Research skills | X | | | | | | | | | | |
| V Team work | X | | | | | | | | | | |

**Lab Course Content**

| List of labs to be conducted | 56 h rs. |
|---|---|
| 1. Understanding of simple and compound microscopes.<br>2. To study different cell types such as buccal epithelial cells, striated muscle cells using Methylene blue/any suitable stain (virtual/ slide/slaughtered tissue).<br>3. To study the different stages of Mitosis in root tip of *Allium cepa*.<br>4. To study the different stages of Meiosis in grasshopper testis (virtual/ slides).<br>5. To check the permeability of cells using salt solution of different concentrations.<br>6. Study of parasites in humans (e.g. Protozoans, Helminthes in compliance with examples being studied in theory) permanent micro slides.<br>7. To learn the procedures of preparation of temporary slides (fish scale) and permanent slides, with available mounting material (sex comb of Drosophila/ insect mouth parts).<br>8. Study of life cycles of *Drosophila* sp. (from Cultures or Photographs).<br>9. Preparation of polytene chromosomes (Chironomus larva or Drosophila larva).<br>10. Preparation of human karyotype and study the chromosomal structural and numerical aberrations from the pictures provided. (Virtual/optional).<br>11. To prepare family pedigrees.<br>12. https://www.vlab.co.in<br>13. https://zoologysan.blogspot.com<br>14. www.vlab.iitb.ac.in/vlab<br>15. www.onlinelabs.in<br>16. www.powershow.com<br>17. https://vlab.amrita.eduhttps://sites.dartmouth.edu/ | |

## Suggested Readings:


1. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
2. Alberts et al: Molecular Biology of the Cell: Garland (2002).
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
5. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby- Kuby Immunology. W H Freeman (2007).
6. Kesar, Saroj and Vasishta N.2007 Experimental Physiology: Comprehensive Manual. Heritage Publishers, NewDelhi.


**Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar**

| Formative Assessment | |
|---|---|
| Assessment Occasion | Weightage in Marks |
| House Examination/Test | 05 |
| Written Assignment/Presentation/Project /Term papers/Seminar | 05 |
| Records | 05 |
| Viva | 05 |
| Class performance/Participation | 05 |
| **Total** | **25** |

**Semester II- Zoology**
**Core Course Content:**

| | |
|---|---|
| Course Title: **Biochemistry and Physiology** | Course Credits: **4** |
| Course Code: **DSCC5Z00T2** | L-T-P per week: **4-0-0** |
| Total Contact Hours**: 56** | Duration of ESA: **3 Hours** |
| Formative Assessment Marks: **40** | Summative AssessmentMarks:**60** |
| Model Syllabus Authors: | |

**Course outcomes:**

The student at the completion of the course will learn:

1. To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates.
2. How simple molecules together form complex macromolecules.
3. To understand the thermodynamics of enzyme catalyzed reactions.
4. Mechanisms of energy production at cellular and molecular levels.
5. To understand various functional components of an organism.
6. To explore the complex network of these functional components.
7. To comprehend the regulatory mechanisms for maintenance of function in the body.

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)**

| **Course Outcomes (COs) / Program Outcomes (POs)** | **CC 1** | **CC T2** | **CC 3** | **CC 4** | **CC 5** | **CC 6** | **CC 7** | **CC 8** | **CC 9** | **CC 10** | **CC 11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I Core competency | | X | | | | | | | | | |
| II Critical thinking | | X | | | | | | | | | |
| III Analytical reasoning | | X | | | | | | | | | |
| IV Research skills | | X | | | | | | | | | |
| V Team work | | X | | | | | | | | | |

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark =X 'in the intersection cell if a course outcome addresses a particular program outcome.

## Core Course content:

| Content | Hours |
|---|---|
| **Unit I** | **14** |
| **Chapter 1. Structure and Function of Biomolecules:**<br>• Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates).<br>• Lipids (saturated and unsaturated Fatty acids, Tri-acyl glycerols, Phospho lipids, Glycolipids and Steroids)<br>• Structure, Classification and General Properties of a-amino acids; Essential and non-essential amino acids, Levels of organization in proteins; Simple and conjugate proteins. | |
| **Chapter 2. Enzyme Action and Regulation**<br>• Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action.<br>• Isozymes; Mechanism of enzyme action. Clinical use of Isozymes.<br>• Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Equation of Michaelis-Menten, Concept of Km and V max, Enzyme inhibition.<br>• Allosteric enzymes and their kinetics; Regulation of enzyme action. | |
| **Unit 2** | **14** |
| **Chapter 3. Metabolism of Carbohydrates and Lipids**<br>• Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway Glycogenolysis and Glycogenesis Lipids- Biosynthesis of palmitic acid; Ketogenesis,<br>• β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon-atoms | |
| **Chapter 4. Metabolism of Proteins and Nucleotides**<br>• Catabolism of amino acids: Transamination, Deamination, Urea cycle, Nucleotides and vitamins<br>• Peptide linkages | |
| **Unit 3** | **14** |

| | |
|---|---|
| **Chapter 5. Digestion and Respiration in humans**<br>• Structural organization and functions of gastrointestinal tract and associated glands.<br>• Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Physiology of trachea and Lung.<br>• Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood, Respiratory pigments, Dissociation curves and the factors influencing it;<br>• Control of respiration. | |
| **Chapter 6. Circulation and Excretion in humans**<br>• Components of blood and their functions; haemopoesis<br>• Blood clotting: Blood clotting system, Blood groups: Rh-factor, ABO and MN<br>• Structure of mammalian heart<br>• Cardiac cycle; Cardiac output and its regulation, Electrocardiogram, Blood pressure and its regulation<br>• Structure of kidney and its functional unit; Mechanism of urine formation | |
| **Unit IV** | **14** |
| **Chapter 7. Nervous System and Endocrinology in humans**<br>• Structure of neuron, resting membrane potential(RMP)<br>• Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers. Types of synapse<br>• Endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas and adrenal; hormones secreted by them.<br>• Classification of hormones; Mechanism of Hormone action. | |
| **Chapter 8. Muscular System in humans**<br>• Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus | |

**Suggested Readings:**


I. Nelson & Cox: Leininger ‘s Principles of Biochemistry: McMillan (2000)
2. Zubay et al: Principles of Biochemistry: WCB (1995)
3. Voet & Voet: Biochemistry Vols l & 2: Wiley (2004)
4. Murray et al: Harper ‘s Illustrated Biochemistry: McGraw Hill (2003).
5. Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press
6. Guyton, A.C & Hall, J.E. Textbook of Medical Physiology, Xl Ed. W.B.Saunders Co. (2006).
7. Tortora, G.J. &Grabowski, S. Principles of Anatomy & Physiology. XI Ed. John Wiley & sons (2006).
8. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Ed. Pearson Education (2016).
9. Hill, Richard W., et al. Anima l physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
10. Chatterjee CC Human Physiology Volume l & 2, 11th edition, CBS Publishers (20 I6).

## Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar

| **Formative Assessment** | |
|---|---|
| **Assessment Occasion** | **Weightage in Marks** |
| **House Examination/Test** | **20** |
| **Written Assignment/Presentation/Project / Term Papers/Seminar** | **15** |
| **Class performance/Participation** | **05** |
| **Total** | **40** |

## Zoology Semester II Core Course Lab Content

| Course Title/Code: **Biochemistry and Physiology** | Course Credits: **2** |
|---|---|
| Course Code: **DSCC5Z00P2** | L-T-P per week: 0-0-4 |
| Total Contact Hours**: 56** | Duration of ESA: **4** Hours |
| Formative Assessment Marks: **25** | Summative AssessmentMarks:**25** |
| Model Syllabus Authors: | |

**Course Outcomes (COs):**

At the end of the course the student should be able to understand:
Basic structure of biomolecules through model making.
Develop the skills to identify different types of blood cells.
Enhance basic laboratory skill like keen observation, analysis and discussion.
Learn the functional attributes of biomolecules in animal body.
Know uniqueness of enzymes in animal body and their importance through enzyme kinetics.

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)**

| **Course Outcomes (COs) / Program Outcomes (POs)** | **CC P1** | **CC P2** | **CC 3** | **CC 4** | **CC 5** | **CC 6** | **CC 7** | **CC 8** | **CC 9** | **CC 10** | **CC 11** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| I Core competency | | X | | | | | | | | | |
| II Critical thinking | | X | | | | | | | | | |
| III Analytical reasoning | | X | | | | | | | | | |
| IV Research skills | | X | | | | | | | | | |
| V Team work | | X | | | | | | | | | |

**Note:** Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark =X'in the intersection cell if a course outcome addresses a particular program outcome.

**Course Content**

| **List of labs to be conducted** | **Hours** |
|---|---|
| 1. Preparation of models of nitrogenous bases- nucleosides and nucleotides.<br>2. Preparation of models of amino acids and dipeptides.<br>3. Preparation of models of DNA and RNA.<br>4. Qualitative analysis of Carbohydrates, Proteins and Lipids.<br>5. Qualitative analysis of Nitrogenous wastes – Ammonia, Urea and Uric acid.<br>6. Separation of amino acids or proteins by paper chromatography. | 20 |

| | |
|---|---|
| 7. Determination of the activity of enzyme (Urease)-Effect of [S] and determinationof Km and Vmax.<br>8. Determination of the activity of enzyme (Urease) - Effect of temperature andtime.<br>9. Action of salivary amylase under optimum conditions.<br>10. Quantitative estimation of Oxygen consumption by fresh water Crab.<br>11. Quantitative estimation of salt gain and salt loss by fresh water. | 15 |
| 12. Estimation of Hemoglobin in human blood using Sahli's haemoglobino meter. | 15 |
| 13. Counting of RBC in blood usingHemocytometer.<br>14. Counting of WBC in blood usingHemocytometer.<br>15. Differential staining of human blood corpuscles using Leishman stain.<br>16. Recording of blood glucose level by using glucometer. | |
| **Virtual Labs (Suggestive sites)**<br>https://www.vlab.co.in<br>https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab<br>www.onlinelabs.inwww.powershow.com https://vlab.amrita.edu<br>https://sites.dartmouth.edu | 06 |

**Text Books**


1. Nelson & Cox: Leininger's Principles of Biochemistry: McMillan(2000)
2. Zubay et al: Principles of Biochemistry: WCB (1995)
3. Voet&Voet: Biochemistry Vols l & 2: Wiley (2004)
4. Murray et al: Harper 's Illustrated Biochemistry: McGraw Hill (2003)
   Elliott and Elliott:Biochemistry and Molecular Biology: Oxford
   University Press
5. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology, Xl Ed., W.B.Saunders Company. (2006).
6. Tortora, G.J. &Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
7. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal
   Physiology. 3rd Edition,Pearson Education (2016).
8. Hill, Richard W., et al. Anima l physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
9. Chatterjee CC Human Physiology Volume l & 2, 11th edition, CBS Publishers (2016).


**Web References:**

- Mammalian Physiology– www.biopac.com

**TOPICS RECOMMENDED FOR SEMINAR/PROJECT REPORT**

1. Biochemical pathways, their evolutionary background and regulation.
2. Blood groups and their importance.
3. Vital enzymes for human body.
4. Essential and nonessential amino acids.
5. Important body lipids.
6. Significance of animal proteins.
7. Role of carbohydrates in animal body.
8. Role of lipids in structural and functional organization of body.
9. Nature of proteins and nurture of animal body.

**Pedagogy: Lectures, Presentations, videos, Virtual Labs, Assignments, Tests,**

**Individual orgroup Field oriented Project Report on or visit to a research institute**.

| **Formative Assessment** | |
|---|---|
| **Assessment Occasion** | **Weightage in Marks** |
| Assignment/Monograph | 05 |
| Test | 05 |
| Record | 05 |
| Viva | 05 |
| Participation in class | 05 |
| **Total** | **25** |

# III Semester BSc Zoology
# Core Course Content

| | |
|---|---|
| Course Title/Code: **Molecular Biology, Bioinstrumentation & Techniques in Biology** | Course Credits: **4** |
| Course Code: **DSCC5ZOOT3** | L-T-P per week: 4-0-0 |
| Total Contact Hours**: 56** | Duration of ESA: 3 Hours |
| Formative Assessment Marks: 4**0** | Summative Assessment Marks:**60** |
| Model Syllabus Authors: | |

**Course Outcomes (COs):**

At the end of the course the student should be able to understand:

1. After successful accomplishment of the course, the learners will be able to acquire better understanding and comprehensive knowledge regarding most of the essential aspects of Molecular Biology subject which in turn will provide a fantastic opportunity to develop professional skill related to the field of molecular biology.
2. The course will mainly focus on the study of principal molecular events of cell incorporating DNA Replication, Transcription and Translation in prokaryotic as well as eukaryotic organisms.
3. Acquiring knowledge on instrumentation and techniques in biology.

**Semester III- Zoology**
**Core Course III Content:**

| Content | Hours |
|---|---|
| **Unit I** | **14** |
| **Chapter 1: Process of Transcription**<br>• Fine structure of gene (Cistron, Recon, Muton)<br>• RNA polymerases - types and functions<br>• Transcription in prokaryotes and eukaryotes | 8 |
| **Chapter 2: Process of Translation**<br>• Genetic code and its salient features<br>• Translation in prokaryotes and eukaryotes | 6 |
| **Unit II** | **14** |
| **Chapter 3. Regulation of Gene Expression-I**<br>• Regulation of gene expression in prokaryotes- lac operon (inducible) and trp operon (repressible) in *E. coli*<br>• Regulation of gene expression in eukaryotes - Role of chromatin (Euchromatin and Heterochromatin) in gene expression<br>• Post-transcriptional modification: capping, splicing, polyadenylation<br>• Concept of RNA editing (mRNA), gene silencing, and, RNAi<br>• | 9 |
| **Chapter 4. Regulation of Gene Expression-II**<br>• Post-translational modifications: purpose, advantages, and significance; glycosylation, methylation, phosphorylation, and acetylation.<br>• Intracellular protein degradation (lysosomal autophagy and ubiquitin proteasome pathway). | 5 |

| Unit III | 14 |
|---|---|
| **Chapter 5: Microscopy**<br>• Principles and applications of Light microscopy, Dark field microscopy, Phase contrast microscopy, Fluorescence microscopy, Confocal microscopy and Electron microscopy (SEM and TEM). | 9 |
| **Chapter 6: Centrifugation and Chromatography**<br>• Principle of centrifugation.<br>• Types of centrifuges: High speed and Ultracentrifugation.<br>• Principle and applications of Chromatography: TLC and HPLC. | 5 |
| **Unit IV** | **14** |
| **Chapter 7: Biochemical Instrumentation**<br>• Colorimetry and Spectrophotometry: Beer-Lambert's law, Absorption spectrum, UV-VL Spectrophotometer.<br>• pH meter, measurement of pH<br>• Principle, applications and safety measures of Radio-tracer techniques - Autoradiography. | 6 |
| **Chapter 8: Molecular Techniques**<br>• Principle and applications of Agarose gel-electrophoresis, SDS-PAGE, DNA Sequencing (Sanger's method)<br>• PCR, DNA Fingerprinting, ELISA, Southern Blotting and Western Blotting. | 8 |

**Suggested Readings:**

**Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar**

| **Formative Assessment** | |
|---|---|
| **Assessment Occasion** | **Weightage in Marks** |
| **House Examination/Test** | 15 |
| **Written Assignment/Presentation/Project / Term** | 15 |
| **Class performance/Participation** | 10 |
| **Total** | **40** |

## Zoology

## Core Course Lab Content

**Semester III (Practical III)**

| | |
|---|---|
| Course Title: **Molecular Biology, Bioinstrumentation and Techniques in Biology** | Course Credits: **2** |
| Course Code: DSCC5ZOOP3 | L-T-P per week: 0-0-4 |
| Total Contact Hours**: 56** | Duration of ESA: 3 Hours |
| Formative Assessment Marks: **25** | Summative Assessment Marks:**25** |

**Course Outcomes (COs):**

At the end of the course the student should be able to:

1. At the end of the course, students will be able to understand the applications of biophysics and principle involved in bio-instruments.
2. Understand the methodology involved in bio techniques.
3. Students can Demonstrate knowledge and practical skills of using instruments in biology and medical field.
4. They can perform techniques involved in molecular biology and diagnosis of diseases.

**Lab Course Content**

| List of experiments | 14 units (1unit- 4hrs) |
|---|---|
| 1. To study the principle and applications of simple, compound and binocular microscopes. | 1 |
| 2. To study the principle and applications of various lab equipments- pH meter, Electronic balance, Vortex mixer, use of glass and micropipettes, Laminar air flow, Incubator, shaker, Water bath and centrifuge. | 2 |
| 3. To prepare Buffer solutions (Phosphate, Citrate, Tris-HCl buffer) | 1 |
| 4. To estimate amount of RNA by Orcinol method. | 2 |
| 5. Demonstration of differential centrifugation to fractionate components in a given mixture. | 1 |
| 6. To estimate amount of protein by Lowry's method. | 2 |
| 7. To identify different unknown amino acids using ascending paper chromatography. | 1 |
| 8. Extraction of DNA from the given animal tissue sample. | 2 |
| 9. To estimate amount of DNA by di-phenyl amine (DPA) method. | 2 |

**Suggested Readings:**


1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. Molecular Biology of the Cell, 4th edition. New York: Garland Science (2002).
2. Daniel L. Hartl and Maryellen Ruvolo. Genetics: Analysis of Genes and Genomes, 8th Edition. Burlington, Mass.: Jones & Bartlett Learning (2012).
3. Gerald Karp. Cell and Molecular Biology: Concepts and Experiments, 5th Edition. Wiley Publication (2008).
4. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Freeman. Molecular Cell Biology, 5th edition. W. H. & Company (2003).
5. James D. Watson, Tania A. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Molecular Biology of the Gene, 5th edition. Cold Spring Harbor Laboratory Press (2003).
6. Stryer, Lubert. Biochemistry, 2nd Edition. W. H. Freeman and Company, New York (1981).

**Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar**

| Formative Assessment | |
|---|---|
| Assessment Occasion | Weightage in Marks |
| House Examination/Test | 05 |
| Written Assignment/Presentation/Project /Term papers/Seminar | 10 |
| Class performance/Participation | 10 |
| **Total** | **25** |

**Zoology/PAPER IV - Gene Technology, Immunology and Computational Biology**
**SEMESTER: - IV Semester**

Semester: **IV Semester, B. Sc., (Hons) Zoology**

| Course Title: **Core Course Content: Gene Technology Immunology and Computational Biology** | Course Code: **DSCC5ZOOT4** |
|---|---|
| Course Type: **Discipline Core Theory, L-T-P: 4-0-0** | Course Credits: **4** |
| Total Contact Hours: **56** | Duration of ESA: **3 Hrs.** |
| Formative Assessment Marks: **40** | Summative Assessment Marks:**60** |

**Course Outcomes (COs):**

**At the end of the course the student should be able to:**

1. Acquaint knowledge on versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
2. An understanding on application of genetic engineering techniques in basic and applied experimental biology.
3. To acquire a fundamental working knowledge of the basic principles of immunology.
4. To understand how these principles, apply to the process of immune function.
5. Use, and interpret results of, the principal methods of statistical inference and design; helps to communicate the results of statistical analyses accurately and effectively; helps in usage of appropriate tool of statistical software.

| **Course Content** | **Hrs.** |
|---|---|
| **Unit I** | **14** |
| **Chapter 1: Principles of Gene Manipulation**<br>● Recombinant DNA Technology: Introduction, steps involved.<br>● Restriction Enzymes and Ligases and Nucleic acid modifying enzyme.<br>● Gene cloning Vector: Concept of plasmids-pBR322, Lamda phage vectors, cosmids<br>● Gene transfer techniques (Direct and indirect).<br>● Screening and selection of recombinant colonies | 07 |
| **Chapter 2: Applications of Genetic Engineering**<br>● Transgenic animals (Transgenic cow, Transgenic Fish); Transgenic plants (cry protein); Gene silencing (Knock out and Knock in mouse).<br>● Production of Human Recombinant insulin and<br>● Hybridoma technology: Synthesis and applications of Monoclonal antibodies<br>● Gene Therapy (SCID)<br>● Biosensors and its applications | 07 |
| **Unit II** | **14** |

| | |
|---|---|
| **Chapter 3: Introduction to the Immune System**<br>• Defence against diseases: Introduction, First and second line of defence, Innate and acquired immunity; Antigen presenting cells (APC's), Role of B and T-lymphocytes (Humoral immunity and cell mediated immunity), primary and secondary immune response.<br>• Types of Ummunity<br>• Functional aspects of organs of the Immune system - Thymus and bone marrow, spleen, Lymph Node, Small intestine and Liver (Peyer's patches and Von Kupffer cells). | 07<br><br>07 |
| **Chapter 4: Antigens and Antibodies**<br>• Antigens and haptens: Properties (foreignness, molecular size, heterogeneity).<br>• B and T cell epitopes.<br>• Structure of IgG and functions of different classes of immunoglobulins.<br>• Major histocompatibility complex - Structure of MHC I & II. | |
| **Unit III** | **14** |
| **Chapter 5: Clinical Immunology**<br>• Immunity against diseases of viral, bacterial and protozoan infections.<br>• Vaccines: Types and Uses - Immunization schedule for children.<br>• Transplantation immunology: Transplantation of organ- Types, graft rejection and Immuno-suppressors. | 07 |
| **Chapter 6: Bioinformatics**<br>• Databases: Sequence and structural<br>• Sequence analysis (homology): Pairwise and Multiple Sequence alignment- BLAST, CLUSTALW, Sequence alignment- FASTA.<br>• Scope and applications of Bioinformatics. | 07 |
| **Unit IV** | **14** |
| **Chapter 7: Biostatistics I**<br>• Measures of central tendency: Mean, Median, Mode.<br>• Data summarizing: Frequency distribution, Graphical presentation - bar diagram, pie diagram, histogram.<br>• Elementary idea of probability and its applications. | 07 |
| **Chapter 8: Biostatistics II**<br>• Measures of dispersion: Range, Standard Deviation, Variance.<br>• Correlation and Regression.<br>• Tests of significance: F-test, ANOVA, t-test and Chi square test. | 07 |

**Topics Suggested for Assignment/ Formative Assessment:**

1. Q/A, Short Question, Quiz, MCQ, Assignment etc.

**Recommended Books:**


1. Primrose &Twyman. Principles of Genome Analysis and Genomics. Blackwell (2003).
2. Hartl& Jones. Genetics: principles &Analsysis of Genes & Genomes. Jones & Bartlett (1998).
3. Sambrook*et al*. Molecular Cloning Vols I, II, III. CSHL (2001).
4. Primrose. Molecular Biotechnology. Panima (2001).
5. Clark & Switzer. Experimental Biochemistry. Freeman (2000)
6. Sudbery. Human Molecular Genetics. Prentice-Hall (2002).
7. Wilson. Clinical Genetics-A Short Course, Wiley (2000).
8. Pasternak. An Introduction to Molecular Human Genetics. Fritzgerald (2000).
9. Biostatistical Analysis (Fourth Edition) by Jerrold H. Zarr, Pearson Education Inc., Delhi.
10. Statistical Methods (Eighth Edition) by G. W. Snecdecor and W. G. Cochran, Willey Blackwell
11. Biostatistics (Tenth Edition) by W.W. Daniel and C. L. Cross, Wiley
12. Introductory Biological Statistics (Fourth Edition) by John E. Havel, Raymond E. Hampton and Scott
    J. Meiners
13. Westhead et al Bioinformatics: Instant Notes. Viva Books (2003)
14. Genetic engineering: Sandhya Mitra BITS, Pilani
15. Principles of Biostatistics Khan and Khanam
16. Transgenic animals: Ranga


**Web Sources:**

**Pedagogy:** Lectures, Presentations, videos, Assignments and Weekly Formative Assessment Tests.

| **Formative Assessment** | |
|---|---|
| **Assessment Occasion** | **Weightage in Marks** |
| Assignment/ Field Report/ Project | 15 Marks |
| Test | 20 Marks |
| Participation in class | 05 marks |
| **Total** | **40 Marks** |

| | |
|---|---|
| Course Title: **Gene Technology, Immunology and Computational Biology** | Course Credits: **02** |
| Course Type: **Minor Discipline Core Practical, L-T-P: 0-0-4** | Corse Code: DSCC5ZOOP4 |
| Total Contact Hours: **56** | Duration of ESA: 3 **Hours** |

| | |
|---|---|
| Formative Assessment Marks: **25** | Summative Assessment Marks: **25** |
| Model Syllabus Authors: | |

**Course Outcomes (COs):**

At the end of the course the student should be able to:

1. Accurately, safely and appropriately use all the equipment regularly used in Molecular Biology (DNA manipulation, including balances, pipettes, electrophoresis and centrifuges).
2. Prepare chemical solution and reagents to the precision appropriate to the task.
3. Demonstrate knowledge of the biochemical basis underpinning the molecular biology techniques.

**Lab IV Course Content**

| List of labs to be conducted | Hours |
|---|---|
| 1. Calculate the mean, median, mode and standard deviation (Measurement of pre and post clitellar lengths (with suitable examples).<br>2. Measure the height and weight of all students in the class and apply statistical measures.<br>3. Determination of ABO Blood group and Rh factor.<br>4. To study Restriction enzyme digestion using teaching kits (Demonstration only).<br>5. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits (Demonstration only).<br>6. Demonstration of agarose gel electrophoresis for detection of DNA.<br>7. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins.<br>8. To calculate molecular weight of unknown DNA and protein fragments from gel pictures. (https://youtube/mCiCiO0cfbg)<br>9. To learn nucleotide sequence database.<br>10. To learn sequence alignment: Pairwise alignment (Protein/ DNA). | |

**Pedagogy:** Lectures, Presentations, videos, Labs, Assignments, Tests, Individual or group Field oriented Project Report**.**

| **Formative Assessment** | |
|---|---|
| **Assessment Occasion** | **Weightage in Marks** |
| Assignment/Monograph | 10 |
| Test | 10 |
| Participation in class | 05 |
| **Total** | **25** |


# BENGALURU CITY UNIVERSITY

**CHOICE BASED CREDIT SYSTEM**

**(Semester Scheme with Multiple Entry and Exit Options for Under Graduate Course)**

## Syllabus for Zoology
## (V & VI Semester)

**2023-24**

## Guidelines For Model Curriculum

1. The Universities shall promote Double Major model as prescribed in the Model Curriculum Table.
2. For Arts/Humanities/Social Science - V & VI sem, three core papers (DSC) to be selected in each semester.
   For Science – Ensure two core papers (DSC) should get minimum of 12 credits/or 2 major subjects of 24 credits (4+2 patterns)
   (1 hour of Lecture or 2 hours of practical/field work per week in a semester is assigned one credit and core subject theory courses/papers will have 4 credits, while practical are assigned 2 credits)
3. Formative assessment and summative assessment to be followed in the ratio of 40:60.
4. Selection of Open electives: The university shall follow curriculum and credit frame work for Undergraduate program of published by UGC. **Open Electives – Courses from other Disciplines (9 Credits)**
   - Students are not allowed to choose or repeat courses as open electives already undergone at the higher secondary level (12th class)
   - All UG students are required to undergo 3 introductory-level courses relating to any of the broad disciplines given below.

| Natural and Physical Sciences | Mathematics, Statistics, & Computer Applications | Library, Information, and Media Sciences | Commerce and Management | Humanities and Social Sciences: |
|---|---|---|---|---|
| Students can choose basic courses from disciplines such as Natural Science, for example, Biology, Botany, Zoology, Biotechnology, Biochemistry, Chemistry, Physics, Biophysics, Astronomy and Astrophysics, Earth and Environmental Sciences, etc. | Courses under this category will facilitate the students to use and apply tools and techniques in their major and minor disciplines. The course may include training in programming software like Python among others and applications software like STATA, SPSS, Tally, etc. Basic courses under this category will be helpful for science and social science in data analysis and the application of quantitative tools | Courses from this category will help the students to understand the recent developments in information and media science (journalism, mass media, and communication) | Courses include business management, accountancy, finance, financial institutions, fintech, etc., | The courses relating to Social Sciences, for example, Anthropology, Communication and Media, Economics, History, Linguistics, Political Science, Psychology, Social Work, Sociology, etc. will enable students to understand the individuals and their social behavior, society, and nation. Students be introduced to survey methodology and available large-scale databases for India. The courses under humanities include, for example, Archaeology, History, Comparative Literature, Arts & Creative expressions, Creative Writing and Literature, language(s), Philosophy, etc., and interdisciplinary courses relating to humanities. The list of Courses that can include interdisciplinary subjects such as Cognitive Science, Environmental Science, Gender Studies, Global Environment & Health, International Relations, Political Economy and Development, Sustainable Development, Women's and Gender Studies, etc. will be useful to understand society. |

## **BSc.-Science:** Curriculum and Credit Framework for Undergraduate Programme

| Sem. | Discipline Specific Courses - Core (DSC), Elective (DSE)(Credits) (L+T+P) | Minor/ Multidisciplinary/ Open Elective (OE) Courses(Credits) (L+T+P) | Ability Enhancement Courses (AEC)(Credits)( L+T+P) (Languages) | Skills Enhancement Courses (SEC) (Credits) (L+T+P)/ Value Added Courses (Credits) (L+T+P) (common for all UG Programs)/ Summer Internship. | | Total Credits |
|---|---|---|---|---|---|---|
| I | DSC-A1(4), A2(2) DSC-B1(4), B2(2) | OE-1 (3) | L1-1(3), L2-1(3) (4 hrs each) | **SEC-1**: Digital Fluency (2) (1+0+2)/ Env. Studies (3) | Health, Wellness & Yoga (2) (1+0+2) | 25/26 |
| II | DSC-A3(4), A4(2), DSC-B3(4), B4(2) | OE-2 (3) | L1-2(3), L2-2(3) (4 hrs each) | Env. Studies (3)/ SEC-1: Digital Fluency (2)(1+0+2) | Sports/NCC/NSS/R&R(S&G) / Cultural (2) (0+0+4) | 26/25 |
| Students exiting the programme after securing 46 credits will be awarded UG Certificate in Disciplines A and B provided they secure 4 credits in work based vocational courses during summer term or internship/Apprenticeship in addition to 6 credits from skill-based courses earned during the first year. | | | | | | |
| III | DSC-A5(4), A6(2), DSC-B5(4), B6(2) | OE-3 (3)/ India and IndianConstitution (3) | L1-3(3), L2-3(3) (4 hrs. each) | **SEC-2**:AI/Cyber Security/Finan-cial Edu. & Inv. Aw. (2) (1+0+2) | Sports/NCC/NSS/R&R(S&G) /Cultural (2) (0+0+4)/ SEC (2) | 25 |
| IV | DSC-A7(4), A8(2), DSC-B7(4), B8(2) | India and Indian Constitution (3) / OE-3(3) | L1-4(3), L2-4(3) (4 hrs. each) | **SEC-3**: Financial Edu. &Inv. Aw. /AI /Cyber Security (2) (1+0+2) | Sports/NCC/NSS/R&R(S&G )/ Cultural (2) (0+0+4)/ SEC (2) | 25 |
| Students exiting the programme after securing 92 credits will be awarded UG Diploma in Disciplines A and B provided they secure additional 4 credits in skill based vocational courses offered during first- or second-year summer term. | | | | | | |
| V | DSC-A9(4), A10(2), A11(4), A12(2); | DSC-B9(4), B10(2), B11(4), B12(2) | | **SEC-4**: Employability Skills/Cyber Security (3) (2+0+2) | | 27 |
| VI | DSC-A13(4), A14(2), A15(4), A16(2); | DSC-B13(4), B14(2), B15(4), B16(2) | | Internship (2) | | 26 |
| Students exiting the programme after 3-years will be awarded UG Degree in Disciplines A and B as double majors upon securing 136 credits and satisfying the minimum credit requirements under each category of courses prescribed. | | | | | | |

## **Internship for graduate Programme (As Per UGC & AICTE)**

| Course title | Internship Discipline specific |
|---|---|
| No of contact hours | 90 |
| No credits | 2 |
| Method of evaluation | Presentations/Report submission/Activity etc., |

- Internship shall be Discipline Specific of 90 hours (2 credits) with a duration 4-6 weeks.
- Internship may be full-time/part-time (full-time during semester holidays and part-time in the academic session)
- Internship mentor/supervisor shall avail work allotment during $6^{th}$ semester for a maximum of 20 hours.
- The student should submit the final internship report (90 hours of Internship) to the mentor for completion of the internship.
- The detailed guidelines and formats shall be formulated by the universities separately as prescribed in accordance to UGC and AICTE guidelines.

# SUBJECT EXPERT COMMITTEE MEMBERS -KSHEC

| S. No. | Name and Organization | Designation |
|---|---|---|
| 1 | Prof. K. Vijaykumar, Department of Zoology, Gulbarga University, Kalaburagi. Ph:.9480060508,katepaga63@gmail.com | Chairman |
| 2 | Prof. P.M Basha, Department of Zoology, Bangalore University, Bengaluru Ph:.9448701652, pmbashabub@rediffmail.com | Member |
| 3 | Prof. Vijaykumar B Malashetty, Department of Zoology, VSK University, Ballari. Ph:.9343011567,vijaymalashetty@gmail.com | Member |
| 4 | Prof. S. Basavarajappa, Mysore University, Mysuru. Ph:.9449203241, E-mail: ornithoraj11@gmail.com | Member |
| 5 | Prof. Nagaraj, Department of Zoology, Kuvempu University, Shivamogga. Ph:.9620485338 | Member |
| 6 | Prof. Kareemunnisa Syed, Nrupathunga University, Bengaluru, Ph:.9964300991, kareemunnisa66@gmail.com | Member |
| 7 | Prof. B. Vasanthkumar, Department of Zoology, Sir MVGovt. College,Bhadravathi,Shimoga | Member |
| 8 | Prof. B.K. Meera, Professor, Maharani Cluster University, Bengaluru Ph:.9886409382. | Member |
| 9 | Dr. D. Gangadhara Rao, Professor, Govt. Women's College, Kolar. Ph:.9448984956 | Member |
| 10 | Prof. Shankarappa S.Hatti, Govt. College, Dept. of Zoology, SedamRoad,Kalaburagi.9980391964 | Member |
| 11 | Dr. Zeba Parveen Dept. Of Zoology, Bi Bi Raza Women's Degree College, Kalaburagi. Ph:.9448092786 | Member |
| 12 | Dr. Asiya Nuzhath F.B, Associate Professor, Dept. Of Zoology, Tumkur University, Tumakuru. Ph:.9844029441 | Member |
| 13 | Ms. Akshatha, Special Officer, KSHEC, Bengaluru. Ph:.9535487108 | Member Convener |

# Bengaluru City University Subject Committee BOS members for Zoology

| SN | Name& Organization | Designation |
|---|---|---|
| 1 | Dr. P. MAHABOOB BASHA, Prof. of Zoology, Bangalore University, Bangalore-560056. | Chairman |
| 2 | Dr. HEMALATHA A. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001. | Member |
| 3 | Dr. SHABANA BEGUM. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001 | Co-opted Member(E) |
| 4 | Dr. LATHA, V. Asso. Prof. of Zoology, Maharani Cluster University, Bangalore- 560001 | Co-opted Member(E) |
| 5 | Mr. CHANDRAPPA, Associate Prof. of Zoology, GFGC, Yelahanka, Bangalore. 9886884996. | Member |
| 6 | Mrs. DHANALAKSHMI. N, Asst. Prof of Zoology, Vijaya College, RV Road, Bangalore-560004. | Member |
| 7 | Dr. C.E. TRIVENI, V.V. Puram College of Science, K. R. Road, Bangalo | Member |
| 8 | Dr. SHUBHA M, Assistant Professor in zoology, BMS College for Women, Bengaluru-560004. | Member |
| 9 | Dr. BHUSHANAM. Asso. Prof. of Zoology, Maharani Cluster Universit Bangalore- 560001 | Co-opted Member(E) |

Note:

1. Sl. No 3-4 & 9 were co-opted in the place of Superannuated BOS members.

(P. MAHABOOB BASHA)
Chairman, BOS (UG)Zoology, BCU

**V SEMESTER B.Sc., ZOOLOGY THEORY SYLLABUS**
**DISCIPLINE SPECIFIC CORE COURSE (DSCC)**

**THEORY PAPER: NON-CHORDATES AND ECONOMIC ZOOLOGY**

# 1. Course Description

| | | | |
|---|---|---|---|
| Program Name | **B.Sc.,** | Semester | V |
| Course Title | **Non-Chordates and Economic Zoology (Theory)** | | |
| Course Code: | DSC**C5 ZOO -T5** | No. of Credits | **4** |
| Contact hours | **60 Hours** | Duration of SEA/Exam | **2 hours** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Pre-requisite(s):** Objectives:

- To learn the morphological characters and structure of animals
- To inculcate the identification abilities in the learners of no- chordate diversity
- To acquire the knowledge of economic animals

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Out comes (POs)**

| **Course Out comes(COs)/(POs)** | DSC**C5 ZOO -T5** | **ZOO C5P** | **ZOO C6T** | **ZOO C6P** | **ZOO C7T** | **ZOO C7P** | **ZOO C8T** | **ZOO C8P** |
|---|---|---|---|---|---|---|---|---|
| I Core competency | X | | | | | | | |
| II Critical thinking | X | | | | | | | |
| III Analytical reasoning | X | | | | | | | |
| IV Research skills | X | | | | | | | |
| V Team work | X | | | | | | | |

Course Articulation Matrix relates course outcomes of course with the corresponding program out comes whose attainment is attempted in this course. Mark 'X' in the inter section cell if a course outcome addresses a particular program

**Course Out comes (COs**): After the successful completion of the course, the student will be able to:

CO1. Group animals on the basis of their morphological characteristics/structures.
CO2. Demonstrate comprehensive identification abilities of Non-Chordate diversity

CO3.Explain structural and functional diversity of Non-Chordates

CO4. Develop the knowledge of economic animals.

| Contents | 60 Hrs |
|---|---|
| **Unit-I** | **15** |
| **Chapter 1: Protozoa to Cnidaria**<br>**Phylum Protozoa**<br>• *Paramecium caudatum*- Morphology, Reproduction- Binary fission & Conjugation.<br>**Phylum Porifera**<br>• *Sycon*- Canal system.<br>**Phylum Coelenterata:**<br>• *Obelia*- Morphology and Reproduction. | |
| **Chapter 2: Ctenophora to Nemathelminthes**<br>**Ctenophora:**<br>• Salient feature and affinities.<br>**Phylum Platyhelminthes:**<br>• *Taenia solium*- Morphology and reproduction.<br>**Phylum Nemathelminthes**<br>• *Ascaris lumbricoides*-Morphology and Reproduction. | |
| **Unit-II** | **15** |
| **3. Annelida**<br>• *Hirudinaria granulosa* (Leech)-Morphology and Reproduction | |
| **4. Arthropoda**<br>• *Palaemon* (Prawn)- Morphology, Appendages, Nervous System and reproduction | |
| **Unit-III** | **15** |
| **6. Mollusca to Hemichordata**<br><br>**Mollusca**<br>• *Pila globosa*- Morphology, Shell, Respiration, Nervous System and Reproduction<br><br>**Echinodermata**<br>• *Pentoceros*- Morphology and Water Vascular System<br><br>**Sub Phylum: Hemichordata**<br>• Type Study of *Balanoglossus*–Habit and Habitat, Morphology, Coelom.<br>• Tornaria larva.<br>• Systematic position of Hemichordata. | |
| **Unit-IV** | **15** |
| **7. Economic Zoology Part -I**<br>Life cycle and control of:<br>• Gundhi Bug<br>• Sugarcane leaf hopper<br>• Mosquitoes | |
| **8. Economic Zoology part II**<br>• Lac culture and Vermitechnology | |

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes**

**Pedagogy:** Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

| Formative Assessment for Theory | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| House Examination/Test | 15 |
| *Written Assessment/Presentation/Project/Term Papers/Seminars | 15 |
| Classroom Performance/Participation | 10 |
| **Total** | **40 Marks** |

**Topics suggested for Continuous Internal Assessment Presentation/ Seminars**

- **Patterns of Organization (Definition and examples).**
- Levels of organization: Protoplasmic, cellular, tissue, organ and organ system grade.
- Body symmetry: Bilateral, Radial and Biradial.
- Germ layers: Diploblastic and Triploblastic.
- Body coelom: Acoelom, Pseudocoelom and Eucoelom.
- General characters of all phyla from Protozoa to Hemichordata and classification up to classes with suitable examples.
- Canal system of sponges
- **Onychophora- Salient features and affinities**
- Soil protozoa, Spongiculture, Economic importance of corals, Vermi-technology, Importance of Honey bees as pollinators and their by-products, Chank Fisheries and economic importance of Echinodermata.
- Pisciculture: Procedure, Composite fish farming, Fish processing and preservation
- Poultry: Indigenous and exotic breeds, Poultry products and by-products
- Dairy: Artificial insemination and MOET, Milk and its by-products, Gobar gas
- Life cycle and control of termites and rodents

## PRACTICAL PAPER: NON-CHORDATES AND ECONOMIC ZOOLOGY

| Course Title | **Non-Chordates and Economic Zoology (Practical)** | Practical Credits | **2** |
|---|---|---|---|
| Course Code | DSC**C5 ZOO -P5** | Contact Hours | **4** |
| Formative Assessment | **25 Marks** | Summative Assessment | **25 Marks** |

**Course Pre-requisite(s):**

1. **To understand the basics of** classification of non-chordates.
2. To learn the diversity of habit and habitat of these species.
3. To develop the skills to identify different classes and species of animals.
4. To know uniqueness of a particular animal and its economic importance

**Course Outcomes(COs):**

At the end of the course the student should be able to:

1. Understand basics of classification of non-chordates.
2. Learn the diversity of habit and habitat of these species.
3. Develop the skills to identify different classes and species of animals.
4. Know uniqueness of a particular animal and its importance

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Out comes (POs)**

| **Course Out comes(COs)/(POs)** | **ZOO C5T** | DSCC**5ZOO -P5** | **ZOO C6T** | **ZOO C6P** | **ZOO C7T** | **ZOO C7P** | **ZOO C8T** | **ZOO C8P** |
|---|---|---|---|---|---|---|---|---|
| I Core competency | | X | | | | | | |
| II Critical thinking | | X | | | | | | |
| III Analytical reasoning | | X | | | | | | |
| IV Research skills | | X | | | | | | |
| V Team work | | X | | | | | | |

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X'in the intersection cell if a course outcome addresses a particular program outcome.

| **Practical Content** | **15** |
|---|---|
| 1. Preparation and observation of protozoan culture.<br>2. **Protozoa**: *Amoeba*, *Euglena*, *Noctiluca*, *Paramecium* and *Vorticella* (Permanent slides).<br>3. **Porifera:** *Sycon, Euplectella, Hyalonema, Spongilla* and *Euspongia* | 1 |

| | |
|---|---|
| (Specimens). Study of permanent slides of T.S of *Sycon*, spicules and gemmules.<br>4. **Coelenterata:** *Aurelia* and *Metridium* (Specimens). Slides of *Hydra, Obelia*-polyp and medusa, and *Ephyra* larva, T.S. of *Metridium* passing through mesenteries.<br>5. **Stud y of Corals** - *Astraea, Fungia, Meandrina, Corallium, Gorgonia, Millepora* and *Pennatula.*<br>6. **Helminthes:** *Planaria, Fasciola hepatica* and *Taenia solium*, *Ascaris*-Male and female (Specimens). Slides of T.S. of *Planaria*, T.S of male and female *Ascaris*.<br>7. **Annelida:** *Nereis, Sabella, Aphrodite* and Leech (Specimens) Slide of T.S. of Earthworm through typhlosole.<br>8. **Arthropoda**: *Palaemon, Astracus,* Scorpion, Spider, *Limulus, Peripatus, Millipede, Centipede,* Praying mantis, Termite Queen, Moth, Butterfly, Dung beetle / Rhinocerous beetle (Any six specimens). Crustacean Larvae-Nauplius, Zoea and Mysis.<br>9. **Mollusca:** *Chiton, Mytilus, Aplysia, Pila, Octopus, Sepia* (Specimens) and Glochidium larva (Slide).<br>10. **Shell Pattern**-*Unio, Ostrea, Cypraea, Murex, Nautilus, Patella, Dentalium,* Cuttlebone. (Any four)<br>11. **Echinodermata**: Systematics of Sea-star, Brittlestar, Sea Urchin, Sea cucumber, Sea lily (Specimens). Slides of Bipinnaria larva, Echinopluteus larva and Pedicellaria.<br>**12**. *Balanoglossus* and its T. S. through proboscis<br>**13. Beneficial Non-chordates:**<br>• **Sericulture:** Lifecycle of *Bombyx mori*, Uzifly, Cocoon, Raw silk.<br>• **Apiculture**: Any 2 Species of honeybee and bee wax.<br>• **Pearl Culture**: Pearl Oyster and Natural Pearls.<br>**14. Virtual Dissection/Cultured specimens:** Earthworm – Digestive system, Nervous system, Leech-Digestive System<br>15. **Virtual Dissection/Cultured specimens:** Prawn-Nervous system. Cockroach-Salivary Apparatus and Digestive system. | 1<br><br><br><br>1<br><br><br><br>1<br><br><br>1<br><br><br><br>1<br><br><br>1<br><br>1<br><br>3<br><br>2<br><br>2 |

**Pedagogy:** Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

| **Formative Assessment for Practical** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| House Examination/Test | 10 |
| Written Assessment/Presentation/Project/Term Papers/Seminars | 10 |
| Class room Performance/Participation | 5 |
| **Total** | **25 Marks** |

| References | |
|---|---|
| 1 | Barnes, R.S.K.; Calow,P.; Olive,P.J.W.; Golding,D.W.; Spicer, J.I.(2002) The Invertebrates: Synthesis, Blackwell Publishing. |
| 2 | Hickman,C.; Roberts,L.S.; Keen,S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill. |
| 3 | Holland, P.(2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press. |
| 4 | Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson. |
| 5 | Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home. |
| 6 | Bushbaum, R. (1964). Animals without Back bones. University of Chicago Press. |

## THEORY PAPER: CHORDATES AND COMPARATIVE ANATOMY

| Program Name | **B.Sc.,** | Semester | **V** |
|---|---|---|---|
| Course Title | **Chordates and Comparative Anatomy (Theory)** | | |
| Course Code: | DSC**C5 ZOO –T6** | No. of Credits | **4** |
| Contact hours | **60 Hours** | Duration of SEA/Exam | **2 hours** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Pre-requisite(s): Objectives**

- To inculcate identification abilities of chordate diversity
- To explain structural and functional diversity of chordate diversity
- To understand evolutionary relationship amongst chordates

**Course Outcomes (COs**): After the completion of the course, the student will be able to:
CO1. Demonstrate comprehensive identification abilities of chordate diversity
CO2. Explain structural and functional diversity of chordate diversity
CO3. Understand evolutionary relationship amongst chordates
CO4. Take up research in biological sciences.
CO5. Realize that very similar physiological mechanisms are used in very diverse organisms.
CO6. Get a flavor of research by working on project besides improving their writing skills. It will further enable the students to think and interpret individually.

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)**

| **Course Out comes(COs)/(POs)** | **ZOO C5T** | **ZOO C5P** | DSC**C5ZOO –T6** | **ZOO C6P** | **ZOO C7T** | **ZOO C7P** | **ZOO C8T** | **ZOO C8P** |
|---|---|---|---|---|---|---|---|---|
| I Core competency | | | X | | | | | |
| II Critical thinking | | | X | | | | | |
| III Analytical reasoning | | | X | | | | | |
| IV Research skills | | | X | | | | | |
| V Team work | | | X | | | | | |

Course Articulation Matrix relates course outcomes of course with the corresponding program out comes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

| **Contents** | **60Hrs** |
|---|---|
| **Unit-I** | **10 hrs** |

**Chapter 1: Chordata**

- General characters of chordates and classification upto classes with suitable examples (Basic features to be emphasized).

**Chapter 2: Urochordata**

- Type Study of *Herdmania*- Habit and Habitat, Morphology, Ascidian Tadpole-structure and its retrogressive metamorphosis.

**Chapter 3: Cephalochordata**

- Type Study of *Branchiostoma* (*Amphioxus*)- Habit and Habitat, Morphology, Digestive system, Feeding mechanism, excretory and circulatory systems.

| | |
|---|---|
| **Chapter 4: Agnatha**<br>• General characters of Agnatha and classification up to classes.<br>• Salient features of Cyclostomata with examples<br>• Ammocoete larva and its significance. | |
| **Unit-II** | **16 hrs** |
| **Chapter 5: Vertebrates**<br>• General characters and Classification of different classes of vertebrates (Pisces, Amphibia, Reptilia, Aves, Mammalia) upto living orders with examples.<br>• Differences between Chondrichthyes and Osteichthyes.<br>• Interesting features and evolutionary significance of Dipnoi.<br>• Salient features of Placodermi and Ostracodermi with examples.<br>• Interesting features of *Sphenodon*,and *Archaeopteryx*.<br>• Interesting features of Mammalian orders (Insectivora, Carnivora, Chiroptera, Cetacea, Proboscidia, Ungulata–Perissodactyla and Artiodactyla, and Primates) with examples. | |
| **Unit-III** | **19 hrs** |
| **Chapter 6: General account of Chordates**<br>• Origin of Chordates.<br>•Types of caudal fins, scales and swim bladder in fishes.<br>•Origin of Amphibia.<br>•Neoteny and Paedogenesis.<br>•Adaptive radiation in extinct reptiles with suitable examples.<br>•Temporal fossae in reptiles.<br>•Poison apparatus in snakes.<br>•Parental care in Pisces and Amphibians.<br>•Flight adaptations in birds.<br>•Dentition in mammals. Evolution of molar tooth.<br>•Migration in Pisces and Birds.<br>•Economic zoology- Poultry | |
| **Unit-IV** | **15 hrs** |
| **Comparative Anatomy of Vertebrates**<br>**Chapter 8: Respiratory system**<br>• Comparative account of respiratory system in vertebrates: Pisces (*Scolidon*), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man).<br>**Chapter 9: Circulatory System**<br>• Comparative account of heart and aortic arches in vertebrates: Pisces (*Scoliodon*), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man).<br>**Chapter 10: Excretory System**<br>• Succession of kidney in vertebrates (Pronephros, Mesonephros and Meta nephros kidney).<br>**Chapter 11: Nervous system**<br>• Comparative account of brain in vertebrates: Pisces (*Scoliodon*), Amphibian (Frog), Reptiles (Lizard), Aves (Pigeon) and Mammals (Man). | |

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes**

**Pedagogy:** Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| House Examination/Test | 15 |
| *Written Assessment/Presentation/Project/Term Papers/Seminars | 15 |
| Classroom Performance/Participation | 10 |
| **Total** | **40 Marks** |

Topics suggested for Continuous Internal Assessment Presentation/ Seminars

- General characters of Urochordata and Cephalochordata.
- Interesting features of crocodile
- Economic zoology- Diary, Pisciculture
- Comparative anatomy of Skeletal system: Axial and appendicular.
- Comparative account of heart in vertebrates
- Comparative account of brain in vertebrates

**Practical Paper: Chordates and Comparative Anatomy Zoology**

| Course Title | **Chordates and Comparative Anatomy Zoology (Practical)** | Practical Credits | **2** |
|---|---|---|---|
| Course Code | DSC**C5 ZOO –P6** | Contact Hours | **4** |
| Formative Assessment | **25 Marks** | Summative Assessment | **25 Marks** |

**Course Pre-requisite(s): Objectives**

- To inculcate identification abilities of chordate diversity
- To explain structural and functional diversity of chordate diversity
- To understand evolutionary relationship amongst chordates

**Course Outcomes (COs**): After the completion of the course, the student will be able to:
CO1. Demonstrate comprehensive identification abilities of chordate diversity
CO2. Explain structural and functional diversity of chordate diversity
CO3. Understand evolutionary relationship amongst chordates

| **Practical Content** | **15 units** |
|---|---|
| 1. **Protochordata**<br>Ascidia/*Herdmania* and Amphioxus, T.S. of *Amphioxus* through pharynx and intestine. | **1** |
| 2. **Cyclostomata**<br>*Petromyzon*, Ammocoete larva and *Myxine.* | |
| 3. **Pisces**<br>Cartilaginous Fishes – *Narcine, Trygon, Pristis, Myolobatis*<br>Bony Fishes–Zebra fish, *Hippocampus, Muraena, Ostracion, Tetradon, Pleuronectus, Diodon, Echeneis*. (Any four). | **1** |
| 4. **Ornamental fishes**<br>Siamese, Koi, Oscar, Betta Sp., Neon tetra, Guppies, Goldfish,<br>Angle fish, Rainbow fish, Mollies<br>(Locally available any five aquarium fishes). | **1** |
| 5. **Accessory respiratory organs**<br>*Saccobranchus, Clarias* and *Anabas.* | **1** |
| 6. **Amphibia**<br>- *Rana, Bufo, Ambystoma, Axolotl larva, Necturus and Ichthyophis.* | |
| 7. **Reptilia**<br>Turtle, Tortoise, *Mabuya, Calotes*, Chameleon, *Varanus*. | **1** |
| snakes–*Dryophis*, Rat snake, Brahmini, Cobra, Krait, Russell's viper and *Hydrophis* (Any 4) | **1** |
| 8. **Aves**<br>Beak and feet modifications in Duck, Crow, Sparrow, Parrot, Kingfisher, Eagle or Hawk. (Any four) | **1** |
| 9. **Mammalia**<br>Mongoose, Squirrel, Pangolin, Hedge Hog, Rat and Loris. (Any four) | **1** |
| 10. **Virtual Dissection/Cultured specimens**<br>Shark/Bony fish: Afferent and efferent branchial systems, glosso-pharyngeal and vagus nerves.<br>Rat: Dissection (only demonstration) – Circulatory system (arterial and venous), Urogenital system. | **3** |
| 11. **Skeletal System in Frog and man (Comparative Anatomy):** Skull, vertebrae, girdles and limb bones (Except hands and feet) | **2** |
| **12. Integumentary System (Comparative Anatomy)**<br>Structure of skin in Fish, Frog, Bird and mammal<br>Integumentary derivatives in mammals. | **2** |

**Pedagogy:** Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

| **Formative Assessment for Practical** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| House Examination/Test | 10 |
| Written Assessment/Presentation/Project/Term Papers/Seminars | 10 |
| Classroom Performance/Participation | 5 |
| **Total** | **25 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

| **References** | |
|---|---|
| 1 | Colbert *et al*: Colbert's Evolution of the Vertebrates:A history of the back boned animals through time. (5th ed 2002, Wiley–Liss). |
| 2 | Hildebrand: Analysis of vertebrate Structure (4thed 1995, JohnWiley) |
| 3 | Kenneth V. Kardong (20015) vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill |
| 4 | McFarland *et al.,*: Vertebrate Life (1979, Macmillan publishing) |
| 5 | Parker and Haswell: Text Book of Zoology, Vol. II(1978,ELBS) |
| 6 | Romerand Parsons: The Vertebrate Body (6thed1986, CBS Publishing Japan) |
| 7 | Young: The Life of vertebrates (3rded 2006,ELBS/Oxford) |
| 8 | Weichert C. K. and William Presch (1970). Elements of Chordate Anatomy, Tata McGraw Hills |
| 9 | Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4thedition), McGraw-Hill. |

## Scheme of Practical Examination

## V Semester

PAPER V: DSC**C5 ZOO P5: Non- Chordata & Economic Zoology**

**(Practical based on** DSC**C5 ZOO -T5)**

Duration: 03 Hours Max. Marks: 25

I. Dissect & display/ Chart
   Earthworm/Cockroach: Nervous system/Digestive system (08 M)
II. Dissect & display/ Chart
   Leech: Digestive system/ Cockroach: Salivary gland apparatus (05M)
III. Identify, classify & comment on spots A, B, C and D (3X4 = 12 M)
   (One from Economic Zoology and one slide is compulsory)

## Scheme of Valuation

I – Dissection – 06M; Display – 02 M/ Comments with diagram-8M
II – Mounting – 03M; Comments – 02M/ Comments with diagram-6M
III – Identification & classification – 01M; Diagram & comments – 02M for Each

## V Semester

PAPER VI: DSC**C5 ZOO P6: Chordata & Comparative Anatomy**
**(Practical Based on** DSC**C5 ZOO –T6)**

Duration: 3 Hours Max. Marks: 25

### Scheme of Examination

I. Flag labeling of the display/ Chart given (ONE) [08M]

a. Shark – Afferent/Efferent/Cranial nerves
b. Rat – Circulatory system/Urinogenital system (Arterial/venous) (Male/Female)

II. Comparative anatomy (ONE) [05M]

a. Skeletal system or Integumentary system for comparison
b. Any TWO derivatives of mammalian integument

III. Identification and comment on spotters A to D [3X4 = 12 M]

a. (Slides & Specimens from Protochordates to Mammalia)
b. One slide is compulsory

### Scheme of Valuation

I. Identification of the system – 02M; Flag labeling – 06M (Minimum 06 labels)/ Comments with diagram-8M
II. Diagram & Comments – 05M
III. Identification with classification – 01M; Diagram & Comments – 02 M for each

***

# VI SEMESTER CURRICULUM

| Program Name | **B.Sc.,** | Semester | **VI** |
|---|---|---|---|
| Course Title | **Evolutionary & Developmental Biology (Theory)** | | |
| Course Code: | DSC**C5 ZOO –T7** | No. of Credits | **4** |
| Contact hours | **60 Hours** | Duration of SEA/ Exam | **2hours** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Pre-requisite(s): Objectives**

- To understand the biological evolution on the earth
- To understand various forces influencing the evolution
- To understand how the single cell formed at fertilization forms an embryo and then a full adult organism.

**Course Outcomes(COs)**: After the successful completion of the course, the student will be able to:

- Understand that by biological evolution we mean that many of the organisms that inhabit the earth today are different from those that inhabited it in the past.
- Understand that natural selection is one of several processes that can bring about evolution, although it can also promote stability rather than change.
- Understand how the single cell formed at fertilization forms an embryo and then a full adult organism.
- Integrate genetics, molecular biology, biochemistry, cell biology, anatomy and physiology during embryonic development.
- Understand a variety of interacting processes, which generate an organism's heterogeneous shapes, size, and structural features.
- Understand how a cell behaves in response to an autonomous determinant or an external signal, and the scientific reasoning exhibited in experimental life science.

**Course Articulation Matrix: Mapping of Course Out comes (COs) with Program Out comes (POs)**

| **Course Out comes(COs)/(POs)** | **ZOO C5T** | **ZOO C5P** | **ZOO C6T** | **ZOO C6P** | DSC**C5 ZOO –T7** | **ZOO C7P** | **ZOO C8T** | **ZOO C8P** |
|---|---|---|---|---|---|---|---|---|
| I Core competency | | | | | X | | | |
| II Critical thinking | | | | | X | | | |
| III Analytical reasoning | | | | | X | | | |
| IV Research skills | | | | | X | | | |
| V Team work | | | | | X | | | |

| Contents | 60Hrs |
|---|---|
| **Unit-I** | **15** |
| 1. **Theories of Evolution**<br>• Origin of Life (Contributions of Oparin, Haldane, Stanley Miller's experiment).<br>• Historical review of evolutionary concept: Lamarckism, Darwinism, Modern synthetic theory<br>• Adaptive radiations: Patterns of evolution (Divergence, Convergence, Parallel, Co-evolution) | |
| 2. **Population Genetics**<br>• Microevolution and Macroevolution: allele frequencies, genotype frequencies, Hardy- Weinberg equilibrium<br>• Forces of evolution: Mutation, Natural Selection (Introduction, Types- Stabilising selection, Disruptive selection, Directional selection), Genetic drift (Introduction, Types- Founder's effect, Bottle neck effect). | |
| **Unit-II** | **15** |
| 3. **Direct Evidences of Evolution:**<br>• Fossils- Types of fossils (Petrifactions, Preservations, Impressions, Moulds and casts), Dating of fossils (Carbon-14 dating method and U-Pb dating method)<br>• Phylogeny of horse (Eohippus, Mesohippus, Merichippus, Pliohippus and Equus). | |
| 4. **Species Concept and Extinction**:<br>• Biological species concept (Advantages and Limitations)<br>• Modes of Speciation-Allopatric and Sympatric speciation<br>(Pre- zygotic and Post Zygotic reproductive isolating mechanisms to be emphasized).<br>• Mass extinction (Causes, Names of five major extinctions). | |
| **Unit-III** | **15** |
| 5. **Gamete, Fertilization and Early Development:**<br>Gametogenesis (mechanism of Spermatogenesis and oogenesis), Fertilization, Cleavage pattern, Gastrulation and fate map and morphogenesis- General account in the light of evolution to be emphasized. | |
| 6. **Developmental Genes:**<br>• General concepts of Organogenesis-I (Neurulation process)<br>• Introduction to genetic basis of embryonic development and Developmental control genes (Homeobox genes) | |
| **Unit-IV** | **15** |
| 7. **Early Vertebrate Development**:<br>• Early development of mammals including Placentation, metamorphosis, regeneration (Limb in frog), environmental regulation in Frog. | |
| 8. **Late Development**:<br>• Development of eye and kidney<br>• Mammalian female reproductive cycles- estrous cycle and menstrual cycle and their regulation<br>• Aging: biology of senescence (causes of ageing to be emphasized) | |

| Formative Assessment for Theory | |
|---|---|
| **Assessment Occasion /type** | **Marks** |
| House Examination/ Test | 15 |
| Written Assessment /Presentation/Project/Term Papers/Seminars | 15 |
| Classroom Performance/Participation | 10 |
| **Total** | **40 Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

**Topics suggested for Continuous Internal Assessment Presentation/ Seminars**

- Incomplete fossil record.
- Planes of cleavage
- Types of cleavage
- Influence of yolk on cleavage
- Historical embryology
- Cleidoic egg and its significance
- Mosaic and regulative eggs
- Theories of ageing
- Blastulation – a general account

**Pedagogy:** Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

**Practical Paper: Evolutionary & Developmental Biology**

| | | | |
|---|---|---|---|
| Program Name | **B.Sc.,** | Semester | **VI** |
| Course Title | **Evolutionary & Developmental Biology(Practical)** | | |
| Course Code: | DSC**C5 ZOO –P7** | No. of Credits | **2** |
| Contact hours | **60 Hours** | Duration of SEA/ Exam | **3 hours** |
| Formative Assessment Marks | **25** | Summative Assessment Marks | **25** |

**Course Pre-requisite(s): Course Pre-requisite(s): Objectives**

- To understand the biological evolution on the earth
- To understand various forces influencing the evolution
- To understand how the single cell formed at fertilization forms an embryo and then a full adult organism.

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)**

| **Course Out comes(COs)/(POs)** | **ZOO C5T** | **ZOO C5P** | **ZOO C6T** | **ZOO C6P** | **ZOO C7T** | DSC**C5 ZOO –P7** | **ZOO C8T** | **ZOO C8P** |
|---|---|---|---|---|---|---|---|---|
| I Core competency | | | | | | X | | |
| II Critical thinking | | | | | | X | | |
| III Analytical reasoning | | | | | | X | | |
| IV Research skills | | | | | | X | | |
| V Team work | | | | | | X | | |

Course Articulation Matrix relates course out comes of course with the corresponding program out comes whose attainment is attempted in this course. Mark 'X' in the inter section cell if a course outcome addresses a particular program outcome.

| **Formative Assessment for Practical** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| House Examination/Test | 05 |
| Written Assessment/Presentation/Project/Term Papers/Seminars | 10 |
| Class room Performance / Participation | 10 |
| **Total** | **25 Marks** |
| ***Formative Assessment as per NEP guide lines are compulsory*** | |

| | Practical Content | 15 |
|---|---|---|
| 1. | Study of fossils from models/ pictures. | 2 |
| 2. | Study of homology and analogy from suitable specimens | 2 |
| 3. | Study and verification of Hardy-Weinberg Law by chi square analysis.(Any three problems) | 1 |
| 4. | Types of eggs based on quantity and distribution of yolk: Sea urchin, insect, frog , Chick. | 2 |
| 5. | Study of adaptive radiations in feet of birds and mouth parts of insects. | 2 |
| 6. | Study of mammalian placenta- Histological and morphological types | 2 |
| 7. | Chick Embryology: Egg, Sperm, Primitive streak, 24H, 36H and 48 Hours embryo whole mount. | 2 |
| 8. | Evolution of man- Ramapithecus, Australopithecus, Neanderthal man and Cromagnon man | 2 |
| | | |

**References**


| | |
|---|---|
| 1 | Ridley, M (2004) Evolution (3rd edition) Black well Publishing |
| 2 | Hall, B.K. and Hallgrimson, B (2008) Evolution (4th edition) Jones and Barlett Publishers |
| 3 | Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring, Harbour Laboratory Press. |
| 4 | Campbell, N. A. and Reece J. B. (2011). Biology. IX Edition, Pearson, Benjamin, Cummings. |
| 5 | Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates. |
| 6 | Developmental Biology: T. Subramaniam, (Reprint), Narosa Publishing House Pvt. Ltd., New Delhi |
| 7 | Developmental biology: Werner A. Müller, Springer Science & Business Media. (2012). |
| 8 | Human Embryology and Developmental Biology E-Book: Bruce M. Carlson, Elsevier Health Sciences. |
| 9 | Developmental Biology: Michael J. F. Barresi, Scott F. Gilbert, Oxford University Press. (2019). |

**PAPER: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT &CONSERVATION (THEORY)**

| | | | |
|---|---|---|---|
| Program Name | **B.Sc.,** | Semester | **VI** |
| Course Title | **Environmental Biology, Wildlife Management &Conservations (Theory)** | | |
| Course Code: | DSC**C5 ZOO –T8** | No. of Credits | **4** |
| Contact hours | **60 Hours** | Duration of SEA/Exam | **2Hours** |
| Formative Assessment Marks | **40** | Summative Assessment Marks | **60** |

**Course Pre-requisite(s): Objectives**

- **To understand the interaction between the animals and abiotic factors in the environment**
- To use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues.
- **To** gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management.

**Course Outcomes (COs**): After the successful completion of the course, the student will be able to:

CO1. Develop an understanding of how animals interact with each other and their natural environment.
CO2. Develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues.
CO3.Develop the ability to work collaborative team-based projects.
CO4.Gain an appreciation for the modern scope of scientific inquiry in the field of wildlife conservation management.
CO5.Develop an ability to analyze, present and interpret wildlife conservation Management in formation.

| **Course Out comes(COs)/(POs)** | **ZOO C5T** | **ZOO C5P** | **ZOO C6T** | **ZOO C6P** | **ZOO C7T** | **ZOO C7P** | DSC**C5 ZOO – T8** | **ZOO C8P** |
|---|---|---|---|---|---|---|---|---|
| I Core competency | | | | | | | X | |
| II Critical thinking | | | | | | | X | |
| III Analytical reasoning | | | | | | | X | |
| IV Research skills | | | | | | | X | |
| V Team work | | | | | | | X | |

| **Contents** | **60 Hrs** |
|---|---|
| **Unit-I** | **15** |
| 1 **Ecology:**<br>• Introduction to ecology, Definition, ecosystem, trophic levels, food chain and food web.<br>• Aquatic environment (Pond and marine)<br>• Biomes – definition, Terrestrial (Tundra, alpine, forest, tropical savanna, grassland, desert, wetland)<br>• Ecological factors (Biotic and Abiotic) | |

| Unit-II | 15 |
|---|---|
| 2. **Pollution:**<br>• Definition, types (air, soil, water and thermal), ozone layer depletion, bioaccumulation, Biomagnification and bioremediation.<br>• Effects of all pollution types on animals and plants | |
| **Unit-III** | **15** |
| 3. **Wildlife Conservation:** Causes and depletion of wildlife, Ex-situ and in-situ conservation, National parks, Wildlife sanctuaries, biosphere reserve. Project tiger. Project Elephant, Project Lion, breeding in captivity, Zoological gardens, Wildlife Protection Act 1972. | |
| **Unit-IV** | **15** |
| **4. Wildlife Management:** Values of wildlife, inventory and classification of wetlands and their biotic components, general strategies and issues, concept of home range, wildlife corridors and territory, animal census, tracing movement and remote sensing and GIS. | |

**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs1-15)**

**Pedagogy**: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

| **Formative Assessment for Theory** | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| House Examination/Test | 15 |
| Written Assessment/Presentation/Project/Term Papers/Seminars | 15 |
| Classroom Performance/ Participation | 10 |
| **Total** | **40Marks** |
| ***Formative Assessment as per NEP guidelines are compulsory*** | |

**Topics suggested for Continuous Internal Assessment Presentation/ Seminars**

- Adaptive features of plants and animals to different environment
- Factors: Weather, Climate, Light, soil, temperature
- Biodiversity- Types, hotspots and methods of preservation

**PAPER: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT &CONSERVATIONS (PRACTICAL)**

| | | | |
|---|---|---|---|
| Course Title | **Environmental Biology, Wildlife Management & Conservation (Practicals)** | Practical Credits | **2** |
| Course Code | DSC**C5 ZOO –P8** | Contact Hours | **4 Hours** |
| Formative Assessment | **25Marks** | Summative Assessment | **25 Marks** |

| **Course Out comes(COs)/(POs)** | **ZOO C5T** | **ZOO C5P** | **ZOO C6T** | **ZOO C6P** | **ZOO C7T** | **ZOO C7P** | **ZOO C8T** | **ZOO C8P** |
|---|---|---|---|---|---|---|---|---|
| I Core competency | | | | | | | | X |
| II Critical thinking | | | | | | | | X |
| III Analytical reasoning | | | | | | | | X |
| IV Research skills | | | | | | | | X |
| V Team work | | | | | | | | X |

| **Practical Content** | **15** |
|---|---|
| 1. **Water quality parameters assessment:** Collection of water sample, Dissolved Oxygen ($O_2$), Carbon dioxide ($CO_2$), Biological Oxygen Demand (BOD) Chemical Oxygen Demand (COD), chlorides, Hardness and salinity estimation in water. (Any four) | 5 |
| 2. **Analysis of physico-chemical parameters of soil:** pH, soil moisture, soil temperature, organic matter in soil. | 3 |
| **3. Analysis of air pollution:** Air monitoring for particulate matter | 1 |
| **4. Visit of pond and lakes:** Collection and identification of fauna of selected ecosystems. Collection, preservation of phytoplanktons, zooplanktons and insect larva. | 1 |
| **5. Demonstration of field equipments used in wildlife census:** Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System, Various types of cameras and lenses. | 2 |
| **6. Identification wild animals:** Wild animal's pugmarks, hoof marks scars, pellet groups, nest, antlers. Demonstration of field techniques for wild fauna. | 1 |
| 7. Field visit to nearby National park/ Wildlife sanctuary/ any National laboratory at the end of semester is compulsory and the report of this is to be submitted along with practical record as a part of practical examination. | 2 |

**Pedagogy:** Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests

| Formative Assessment for Practical | |
|---|---|
| **Assessment Occasion/type** | **Marks** |
| House Examination/Test | 05 |
| Written Assessment /Presentation/Project/Term Papers/Seminars | 10 |
| Classroom Performance /Participation | 10 |
| **Total** | **25Marks** |
| ***Formative Assessment asper NEP guidelines are compulsory*** | |

| **References** | |
|---|---|
| 1 | Colinvaux, P. A.(1993) Ecology (2nd edition)Wiley, John and Sons, Inc. |
| 2 | Krebs,C. J.(2001)Ecology(6th edition) Benjamin Cummings. |
| 3 | Odum,E.P., (2008) Fundamentals of Ecology. IndianEdition. Brooks/Cole. (3rd Edition) BlackwellSci. |
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| 5 | Caughley,G. and Sinclair, A.R.E.(1994)Wildlife Ecology and Management. Blackwell Science. |
| 6 | Woodroffe,R., Thirgood, S. and Rabinowitz,A. (2005) People and Wildlife, Conflict Or Co-existence? Cambridge University. |
| 7 | Bookhout,T.A. (1996) Research and Management Techniques for Wildlife and Habitats (5th edition) The Wildlife Society,Allen Press. |
| 8 | Sutherland, W.J. (2000)The Conservation Handbook: Research, Management and Policy. Blackwell Sciences |
| 9 | Hunter M.L., Gibbs,J.B. and Sterling,E.J.(2008) Problem solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory. Blackwell Publishing |

## Scheme of Practical Examination

## VI Semester

**Paper VII: DSCC5 ZOO –P7; Evolutionary and Developmental Biology**
**(Practical Based on** DSC**C5 ZOO –T7)**

**Duration: 03 Hours** **Max. Marks 25 M**

**Practical Examination Scheme**

I. Identify and comment on spotters A and B 3X2 = 06M
(Homologous/Analogous organ/Fossil Model) (Any Two)

II. Problem on Hardy-Weinberg Law- Chi square analysis (Problems related to evolution) 04 M

III. Identify and comment on slide C, D and E 3X4 = 12M
(Frog/Chick embryology slides)

IV. Identify and comment on F 03M
(Any one Human fossil)

## Scheme of Valuation

I. Identification -01 M; Comments - 02M for each

II. Problem 04 M

III. Identification 01 M; Comment with diagram 03 M

IV. Identification 01M; Comments 02M

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## VI Semester

**Paper VIII:** DSC**C5 ZOO –P8 :Environmental Biology Wildlife Management and Conservation**
**(Practical Based on** DSC**C5 ZOO –T8)**

**Duration: 3 hours** **Max. Marks: 25**

I. Estimation of given Water sample for (any one) 12 M
(Dissolved $O_2$/$CO_2$/Hardness/Chloride)

II. Detect the Physico-chemical parameter of the soil (any one) 04 M
(pH, Moisture, Soil temperature, Organic matter)

III. Identify and Comment of the spot A & B 3X2 = 06 M
(Zooplanktons & Fauna of any ecosystem).

IV. Identify the spot C 03 M
(Binocular, Compass, Lens, Camera, GPS and Spotting Scope).

## Scheme of Valuation

I. Principle and procedure -06 M
Conducting experiments – 04M
Result & Comment - 02M

II. Physical parameter - 03M
Comment - 01M

III. Identification - 01M
Comment - 02 M

IV. Identification - 01M
Comment with Application - 02M

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**For B.Sc., III Year V and VI semesters**

**ZOOLOGY AND ANOTHER SUBJECT AS DOUBLE MAJORS IN THIRD YEAR**

| Sem | Disp. | Paper Code | Title | C | T | P | Ex | IA | E | T |
|---|---|---|---|---|---|---|---|---|---|---|
| V | DSC | **C5 ZOO -T5** | Non-chordates and Economic Zoology | 4 | 4 | | 2 hr | 40 | 60 | 100 |
| | | **C5 ZOO -P5** | Practical Based on Zoo **C5 ZOO -T5** | 2 | | 4 | 3 hr | 25 | 25 | 50 |
| | | **C5 ZOO -T6** | Chordates and Comparative Anatomy | 4 | 4 | | 2 hr | 40 | 60 | 100 |
| | | **C5 ZOO -P6** | Practical Based on **C5 ZOO -T6** | 2 | | 4 | 3 hr | 25 | 25 | 50 |
| VI | DSC | **C5 ZOO -T7** | Evolutionary & Developmental Biology | 4 | 4 | | 2 hr | 40 | 60 | 100 |
| | | **C5 ZOO -P7** | Practical Based on **C5 ZOO -T7** | 2 | | 4 | 3 hr | 25 | 25 | 50 |
| | | **C5 ZOO -T8** | Environmental Biology,Wildlife Management & Conservation | 4 | 4 | | 2 hr | 40 | 60 | 100 |
| | | **C5 ZOO -P8** | Practical Based on **C5 ZOO -T8** | 2 | | 4 | 3 hr | 25 | 25 | 50 |

**(C: credits; T: theory; P: Practical; Ex: Exam Duration; IA: Internal Assessment; E: Exam marks; T: Total)**

**Internship Allotment:**

**Since Double Majors Programme Being Followed in Third Year, Students Can Opt/choose Eighter Zoology Or Another Subject as Internship topic.**