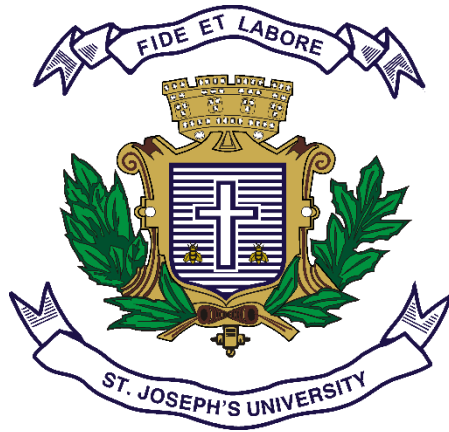


ST. JOSEPH'S UNIVERSITY

BENGALURU-27



DEPARTMENT OF ZOOLOGY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

FOR THE BATCH OF 2021-2024

Course Outcomes and Course Content

Under New Education Policy – Year 2021-22

I Semester B.Sc., Zoology

Core Course Content

Course Title/Code: CYTOLOGY AND GENETICS	Course Credits: 04
Course Code: ZO121	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 04 hrs self-study)	Duration of ESE: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

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 for 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. The organism and also formation of its progeny.
5. How a cell communicates with its neighboring cells.
6. The principles of inheritance, Mendel's laws and the deviations.
7. How the 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 1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8
I Core competency	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	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

UNITS	PART A: CYTOLOGY	
1	Structure of Function of Cell Organelles- I	14 hrs
1.1	<i>Plasma membrane</i> <ul style="list-style-type: none"> • Fluid-Mosaic model • Chemical composition- Lipids, Proteins, Carbohydrates and their role in maintaining structural integrity. 	
1.2	<i>Functions of Plasma membrane</i> <ul style="list-style-type: none"> • Selective permeability • Transportation: Passive transport - Diffusion, Facilitated diffusion, Osmosis. • Active transport - carrier and channel proteins and bulk transport. 	
1.3	<i>Endomembrane system</i> <ul style="list-style-type: none"> • Endoplasmic Reticulum • Golgi apparatus (Self-study) • Lysosomes - synthesis and cis/trans sides of membranes, organization, transport, endocytosis and exocytosis. 	
2	Structure of Function of Cell Organelles- II	
2.1	<i>Cytoskeleton</i> <ul style="list-style-type: none"> • Structure and function -microtubules, microfilaments, intermediate filaments 	
2.2	<i>Mitochondria</i> <ul style="list-style-type: none"> • Structure • Oxidative phosphorylation and Electron transport system. 	
2.3	<i>Peroxisome and Ribosome</i> <ul style="list-style-type: none"> • Structure and Function (Self-study) 	
	PART B	14 hrs
3	Nucleus and Chromatin structure	
3.1	<i>Nucleus and Chromatin structure</i> <ul style="list-style-type: none"> • Structure and function of nucleus in eukaryotes • Structure of chromosome • Nucleosome (chromatin organization) (Self-study) 	
4	Cell cycle, Cell Division and Cell Signaling	
4.1	<i>Cell cycle</i> <ul style="list-style-type: none"> • Cell cycle and regulation • Cell division: Mitosis (Self-study) and meiosis • Apoptosis 	

4.2	<p><i>Cell signaling</i></p> <ul style="list-style-type: none"> • Signal transduction: cell surface receptors, primary and secondary messengers (G-proteins linked receptors-epinephrine) • Cell-cell interaction: cell adhesion molecules, cellular junctions 	
Part-C		14 hrs
5	Mendelism and Extensions of Mendelism	
5.1	<p><i>Basic Principles of Heredity</i></p> <ul style="list-style-type: none"> • Mendel's laws- monohybrid cross and dihybrid cross, test cross, back cross (Self-study) • Penetrance and Expressivity. 	
5.2	<p><i>Extension of Mendelism</i></p> <ul style="list-style-type: none"> • Incomplete dominance, Co-dominance • Multiple alleles-ABO blood groups in man • Rh factor, Rh incompatibility complication Erythroblastosis foetalis 	
5.3	<p><i>Interaction of genes</i></p> <ul style="list-style-type: none"> • Dominant Epistasis comb patterns in fowl • Problems. - plumage in white leghorn and white Plymouth breed of fowls. 	
5.4	<p><i>Polygenic inheritance</i></p> <ul style="list-style-type: none"> • Skin colour in man • Pleiotropy 	
6	Linkage and Sex Determination	
6.1	<p><i>The Interaction Between Sex and Heredity</i></p> <ul style="list-style-type: none"> • Sex-Influenced and Sex-Limited Characteristic: Autosomal vs Sex linked inheritance. • Autosomal traits influenced by sex (baldness, color blindness, etc) • Cytoplasmic inheritance, Genetic Maternal Effects- coiling of shell, <u>kappaparticle in paramecium</u> (Self-study) 	
6.2	<p><i>Chromosomal Sex Determination</i></p> <ul style="list-style-type: none"> • XX-XY, XX-XO, ZZ-ZW and ZZ-ZO types. 	
6.3	<p><i>Dosage compensation</i></p> <ul style="list-style-type: none"> • Barr body, Lyon's hypothesis, Genic balance theory of Bridges, gynandromorphs and free martins • Sex-linked characteristics in humans and dosage compensation. 	
7	Human Chromosomes and Patterns of Inheritance	
7.1	<p><i>Patterns of inheritance</i></p> <ul style="list-style-type: none"> • Autosomal dominance, autosomal recessive, • X-linked recessive, X-linked dominant. 	
7.2	<p><i>Chromosomal anomalies</i></p> <ul style="list-style-type: none"> • Structural and numerical aberrations (Non-disjunction of Sex chromosomes- Turner's syndrome, Klinefelter's syndrome. • Autosomal anomalies - Down syndrome and Cri-du-chat syndrome (Self-study) 	

	<ul style="list-style-type: none"> Human karyotyping and Pedigree analysis 	
8	Gene-environment interaction and Epigenetics	
	<i>Interaction between Genes and Environment:</i> <ul style="list-style-type: none"> Environmental Effects on Gene Expression, <u>Complex traits (Diabetes and CVD) (Self-study)</u> Epigenetic landscape - introduction to Waddington's model. Introduction to heritability Introduction to norm of reaction - California experiment. 	

REFERENCE BOOKS

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

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10

Written Assignment/Presentation/Project /Seminar – II- CA-II	10
Total	40

Question Paper Pattern

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (5 questions)	30
TOTAL		60

PAPER CODE ZO 1P1
ZOOLOGY SEMESTER-I
PRACTICAL I
ZO1P1: CYTOLOGY & GENETICS
Zoology Core Lab Course Content

Semester I

Course Title: CYTOLOGY AND GENETICS	Course Credits: 02
Course Code: ZO 1P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 4 Hours
Formative Assessment Marks: 25	Summative Assessment Marks: 25

Course Outcomes (COs):

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

- Learn to estimate different chemical component of water and soil
- To use simple and compound microscopes.
- To prepare stained slides to observe the cell organelles.
- 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.
- The chromosomal aberrations by preparing karyotypes.
- 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	CC2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

Total Number of Practical Sessions	10 Units
Lab Course Content	
I. CYTOLOGY	06 Units
<ol style="list-style-type: none"> 1. Estimation of Salinity 2. Understanding of simple and compound microscopes. 3. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue/any suitable stain (virtual/slaughtered tissue). 4. To study the different stages of Mitosis in the root tip of <i>Allium cepa</i>. 5. To study the different stages of Meiosis in grasshopper testis (virtual). 6. To learn the procedures of preparation of temporary and permanent stained slides, with available mounting material. 	
II. GENETICS	04 Units
<ol style="list-style-type: none"> 1. Study of mutant phenotypes of <i>Drosophila</i> sp. (from Cultures and permanent slides). 2. Preparation of polytene chromosomes (<i>Drosophila</i> larva) 3. Preparation of human karyotype and study the chromosomal structural and numerical aberrations from the pictures provided. (Virtual/optional) 4. To prepare family pedigree. 	
Important Links	
<ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.eduhttps://sites.dartmouth.edu/ 	

Reference books:

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: Lectures, Presentations, videos, Virtual Labs, Assignments, Tests, Individual or group Field oriented Project Report on or visit to a research institute.

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	25
Practical Internal Assessment	25
Total	50

Course Outcomes and Course Content

Under New Education Policy – Year 2021-22 for

II Semester B.Sc., Zoology

Core Course Content

Course Title/Code: BIOCHEMISTRY AND PHYSIOLOGY	Course Credits: 04
Course Code: ZO221	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 04 hrs self-study)	Duration of ESE: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

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. 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 T1	CC 2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8
I Core competency	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	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 II

UNITS	PART A: BIOCHEMISTRY	
1	Structure of Function of Biomolecules	14 hrs
1.1	<i>Carbohydrates</i> <ul style="list-style-type: none"> • Structure and Biological importance of carbohydrates • Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates. 	
1.2	<i>Lipids</i> <ul style="list-style-type: none"> • Saturated and unsaturated Fatty acids, • Tri-acylglycerols, Phospholipids, Glycolipids, Steroids 	
1.3	<i>Proteins</i> <ul style="list-style-type: none"> • Structure, Classification and General Properties of α-amino acids • Levels of organization in proteins • Simple and conjugate proteins • Essential and non-essential amino acids (Self-study) 	
2	Enzyme Action and Regulation	
2.1	<i>Introduction</i> <ul style="list-style-type: none"> • Nomenclature and classification of enzymes • Cofactors (Self-study) • Specificity of enzyme 	
2.2	<i>Regulation</i> <ul style="list-style-type: none"> • Isozymes; Mechanism of enzyme action 	
2.3	<i>Enzyme kinetics</i> <ul style="list-style-type: none"> • Factors affecting rate of enzyme-catalyzed reactions • Equation of Michaelis - Menten, Concept of K_m and V_{max} • Enzyme inhibition • Allosteric enzymes and their kinetics; Regulation of enzyme action 	
	PART B	14 hrs
3	Metabolism of Carbohydrates and Lipids	
3.1	<i>Metabolism of Carbohydrates:</i> <ul style="list-style-type: none"> • Glycolysis • Citric acid cycle (Self-study) • Gluconeogenesis, Phosphate pentose pathway, Glycogenolysis , Glycogenesis 	
3.2	<i>Lipid Metabolism</i> <ul style="list-style-type: none"> • Biosynthesis of palmitic acid • Ketogenesis • β-oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms. 	
4	Vitamins and Metabolism of Proteins	
4.1	<i>Vitamins</i> <ul style="list-style-type: none"> • Types and Functions (Self-study) 	

4.2	<i>Metabolism of amino acids</i> <ul style="list-style-type: none"> • Peptide linkages • Transamination • Deamination • Urea cycle. 	
Part-C		14 hrs
5	Digestion and Respiration in humans	
5.1	<i>Digestion</i> <ul style="list-style-type: none"> • Structural organization and functions of gastrointestinal tract and associated glands. • Mechanical and chemical digestion of food; • Absorptions of carbohydrates, <u>lipids, proteins, water, minerals and vitamins</u> (Self-study) 	
5.2	<i>Respiration</i> <ul style="list-style-type: none"> • Definition & 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. • Nervous control of respiration 	
6	Circulation and Excretion in humans	
6.1	<i>Circulation</i> <ul style="list-style-type: none"> • Components of blood and their functions • Hematopoiesis • Blood clotting- mechanism • Blood groups: Rh-factor, ABO and MN (Self-study) • Structure of mammalian heart • Cardiac cycle - Cardiac output and its regulation • Blood pressure and its regulation • Electrocardiogram 	
6.2	<i>Excretion</i> <ul style="list-style-type: none"> • Structure of kidney and its functional unit • Mechanism of urine formation. 	
Part-D		14hrs
7	Nervous System and Endocrinology in humans	
7.1	<i>Nervous system</i> <ul style="list-style-type: none"> • Structural organization of the nervous system. • Types of neurons • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers. • Types of synapse 	
7.2	<i>Endocrine organs</i> <ul style="list-style-type: none"> • Endocrine glands - Structure and Function • Pineal, Pituitary, Thyroid, Parathyroid, Pancreas and Adrenal. 	

7.3	<i>Endocrinological regulation and disorders</i> <ul style="list-style-type: none"> • Classification of hormones • Mechanism of Hormone action - Protein (Epinephrine) & Steroid (Testosterone). • <i>Diabetes insipidus</i> and <i>Diabetes mellitus</i>. • Growth hormone disorders- Acromegaly, Gigantism and Dwarfism (Self-study) • Hypothyroidism (Goitre and Cretinism) and Hyperthyroidism (Grave's disease). 	
8	Muscular System in humans	
8.1	<i>Muscular system and infections</i> <ul style="list-style-type: none"> • Histology of different types of muscle (Self-study) • Ultrastructure of skeletal muscle • Molecular and chemical basis of muscle contraction • Characteristics of muscle twitch, motor unit, summation and tetanus 	

REFERENCE 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 1 & 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, XI Edition, Hecourt AsiaPTE Ltd. /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. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
9. Chatterjee CC Human Physiology Volume 1 & 2, 11th edition, CBS Publishers (2016).

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

Question Paper Pattern

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (5 questions)	30
TOTAL		60

PAPER CODE ZO 2P1
ZOOLOGY SEMESTER-II
PRACTICAL II
ZO2P1- BIOCHEMISTRY AND PHYSIOLOGY

Zoology Core Lab Course Content

Semester II

Course Title: BIOCHEMISTRY AND PHYSIOLOGY	Course Credits: 02
Course Code: ZO 2P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 4 Hours
Formative Assessment Marks: 25	Summative Assessment Marks: 25

Course Outcomes (COs):

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

- Basic structure of biomolecules through model making.
- Develop the skills to identify different types of blood cells.
- Enhance basic laboratory skills like keen observation, analysis and discussion. Learn the functional attributes of biomolecules in the animal body.
- Know the uniqueness of enzymes in the 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	CC2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

Total Number of Practical Sessions	10 Units
Lab Course Content	
I. BIOCHEMISTRY	05 Units
<ol style="list-style-type: none"> 1. Preparation of models of amino acids and dipeptides. 2. Qualitative analysis of Carbohydrates, Proteins and Lipids. 3. Qualitative analysis of Nitrogenous wastes – Ammonia, Urea and Uric acid. 4. Separation of amino acids or proteins by paper chromatography. 5. Action of salivary amylase under optimum conditions. 	
II. PHYSIOLOGY	05 Units
<ol style="list-style-type: none"> 1. Quantitative estimation of Oxygen consumption by fresh water Crab. 2. Quantitative estimation of salt gain and salt loss by fresh water. 3. Estimation of Hemoglobin in human blood using Sahli's haemoglobinometer and Recording of blood glucose level by using glucometer. 4. Counting of RBC and WBC in blood using Hemocytometer 5. Differential staining of human blood corpuscles using Leishman stain. 	
Important Links	
<ol style="list-style-type: none"> 1. https://www.vlab.co.in 2. https://zoologysan.blogspot.com 3. www.vlab.iitb.ac.in/vlab 4. www.onlinelabs.in 5. www.powershow.com 6. https://vlab.amrita.eduhttps://sites.dartmouth.edu/ 7. https://sites.dartmouth.edu 8. Mammalian Physiology– www.biopac.com 	

Reference 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 1 & 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, XI Edition, Hecourt Asia PTE Ltd. /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. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
9. Chatterjee CC Human Physiology Volume 1 & 2, 11th edition, CBS Publishers (2016).

Pedagogy: Lectures, Presentations, videos, Virtual Labs, Assignments, Tests, Individual or group Field oriented Project Report on or visit to a research institute.

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	25
Practical Internal Assessment	25
Total	50

Course Outcomes and Course Content

under New Education Policy – Year 2022-23

III Semester B.Sc., Zoology Core Course

Content

Course Title/Code: Molecular Biology, Tools and Techniques in Biology	Course Credits: 4
Course Code: ZO322	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 4 hrs.self-study)	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

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 molecular basis of Nucleic acids.
2. The Central Dogma of Molecular biology.
3. The basics of Gene expression and regulation
4. How DNA damage and Repair occurs in cells
5. Familiarize the Basics of tools and techniques used in biology
6. Basics of Bioinformatics as a tool in biology.

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

Course Outcomes (COs) / Program Outcomes (POs)	CC T1	CC2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

UNITS		PART A- Molecular Biology	
1	NUCLEIC ACIDS		5 HRS
	<p><i>Structure and Properties of DNA and RNA:</i></p> <ul style="list-style-type: none"> DNA as genetic material Watson and Crick model of DNA Different forms of DNA (A, B and Z) – (Self-study) Chargaff's rule Structure and functions of different types of RNA - mRNA, tRNA and rRNA 		
2	CENTRAL DOGMA IN MOLECULAR BIOLOGY		16 HRS
2.1	<p><i>DNA replication:</i></p> <ul style="list-style-type: none"> Mechanism of prokaryotic DNA replication Models of replications in prokaryotes Fidelity of replication (Self-study) Eukaryotic DNA polymerases a Mechanism of replication (semi conservative type) (Meselson and Stahl expt.) Steps involved in activation, unwinding, formation of RNA primers, Okazakifragments 		6 hrs
2.2	<p><i>Transcription:</i></p> <p>Characteristics and function of bacterial RNA polymerases</p> <ul style="list-style-type: none"> Mechanism of transcription Eukaryotic RNA polymerases- transcription factors, mechanism of transcription Post transcriptional modifications of mRNA (5' CAP formation, polyadenylation, mechanism of splicing) 		6 hrs
2.3	<p><i>Translation:</i></p> <ul style="list-style-type: none"> Genetic code characteristics, Wobble hypothesis Mechanism of translation in prokaryotes and eukaryotes Differences between prokaryotic and eukaryotic protein synthesis, codon usage Co and posttranslational modifications of proteins 		4 hrs
3	GENE REGULATION, DNA DAMAGE AND REPAIR		7 HRS
3.1	<p><i>Regulation of Gene expression:</i></p> <ul style="list-style-type: none"> Gene regulation, Operon model-Inducible and repressible systems, lac, trpoperon <u>Attenuation, positive and negative regulation- self-study</u> Regulation of eukaryotic gene expression, transcriptional control, cis control elements, promoters, enhancers, transacting factors 		4 hrs
3.2	<p><i>DNA damage and Repair:</i></p> <ul style="list-style-type: none"> DNA damage- alkylation, deamination, oxidation, UV radiation 		3 hrs

	<ul style="list-style-type: none"> Repair mechanisms- excision repair and definitions of photoreactivation, mismatch repair and SOS repair 	
	PART – B TOOLS AND TECHNIQUES IN BIOLOGY	
4	MICROSCOPY	5 HRS
	Working principle and components <ul style="list-style-type: none"> Compound microscope (Self-study) Fluorescent microscope Phase-contrast microscope Electron microscope 	
5	CENTRIFUGATION TECHNIQUES	3 HRS
	<ul style="list-style-type: none"> Types of centrifuges and rotors (Self-study) Density gradient differential centrifugation and ultracentrifugation 	
6	PRINCIPLE AND APPLICATIONS OF POLYMERASE CHAIN REACTION	3 HRS
	<ul style="list-style-type: none"> PCR (Polymerase Chain Reaction) RT- PCR (Reverse Transcriptase) Q-PCR (Real-time/ Quantitative) 	
7	PRINCIPLE AND APPLICATIONS OF GEL ELECTROPHORESIS	3 HRS
	Agarose Gel electrophoresis- Native PAGE, SDS-PAGE	
8	DNA SEQUENCING AND ANALYZATION	4 HRS
	<ul style="list-style-type: none"> Di-deoxy method of sequencing Sanger’s method of sequencing DNA Fingerprinting and <u>RFLP</u> (Self-study) 	
9	PRINCIPLE AND APPLICATIONS OF BLOTTING TECHNIQUES	3 HRS
	<ul style="list-style-type: none"> Southern blotting Western blotting Northern blotting (Self study) 	
10	CHROMATOGRAPHIC TECHNIQUES	4 HRS
	Paper Chromatography- TLC, Column Chromatography- Ion exchange chromatography, Affinity chromatography and Gel filtration technique	
11	BIOINFORMATIC TECHNIQUES	3 HRS
	<ul style="list-style-type: none"> Introduction NCBI, EMBL, DDBJ Nucleotide Databases Search tool: BLAST and FASTA Local and Globalsequence alignment Protein Database- PDB (Self-study) 	

REFERENCE BOOKS

- i. Harvey lodish, arnold berk, paulmatsudaira, chris a. Kaiser, montykrieger, matthew p. Scott, s. Lawrence zipursky and jamesdarnell. (2003). Molecular cell biology, w.h. freeman and company, new york.
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- iii. Watson, J.D., Baker,a.t. and bell, p.s. (2008). Molecular biology of gene. 5th edition. Pearson education inc.
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- v. Cell biology, genetics, molecular biology evolution & ecology, agarwal v. K. And vermap.s , s.Chand & company pvt ltd
- vi. Dhananjaya (2002). Introduction to bioinformatics, www.sd-bio.com series
- vii. Higgins &taylor (2000). Bioinformatics, oup.
- viii. Genes and Genomes by Watson.

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

QUESTION PAPER PATTERN

Semester 3

ZO321- Molecular Biology, Tools and Techniques in Biology

Questions	With choices	Total mark
1 mark	10 x 1	10
5 mark	4 x 5 (6 questions)	20
10 mark	3 x 10 (4 questions)	30
TOTAL		60

PAPER CODE ZO 3P1

ZOOLOGY

SEMESTER-III

PRACTICAL III

ZO 3P1: MOLECULAR BIOLOGY, TOOLS AND TECHNIQUES IN BIOLOGY

Zoology Core Lab Course Content

Semester III

Course Title: Molecular Biology, Tools and Techniques in Biology	Course Credits: 2
Course Code: ZO 3P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	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. Extract DNA and Protein from Animal samples.
2. Able to Estimate the concentration of Nucleic acids and Proteins in the given samples using colorimeter
3. To be familiar with the Tools used in Biology
4. Develop the skills to understand the techniques used in biology
5. Aware of using Bioinformatics Databases

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

Course Outcomes (COs) / Program Outcomes (POs)	CC P1	CC2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

Lab Course Content

1. Extraction of Genomic DNA from liver tissue
2. Estimation of DNA by Diphenylamine method
3. Estimation of RNA by Orcinol method
4. Extraction of Protein from animal tissue.
5. Estimation of Protein by Lowry's method.
6. DNA amplification through PCR [thermocycler]
7. Agarose Gel Electrophoresis.
8. Types of centrifuges and rotors -Working of Centrifuge.
9. Online Databases- NCBI, EMBL and DDBJ, Search tool- BLAST and FASTA.
10. Pair wise comparison of sequences, multiple alignments of sequences for Evolutionary studies / Phylogenetic analysis.

Virtual Labs (Suggestive sites)

<https://www.vlab.co.in>

<https://zoologysan.blogspot.com>

www.vlab.iitb.ac.in/vlab

www.onlinelabs.in

www.powershow.com

<https://vlab.amrita.edu>

<https://sites.dartmouth.edu>

Pedagogy: Lectures, Presentations, videos, Virtual Labs, Assignments, Tests, Individual or group Field oriented Project Report on or visit to a research institute.

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I- CA-1	10
Written Assignment/Presentation/Project /Seminar – II- CA-II	10
Total	40

Course Outcomes and Course Content

Under New Education Policy – Year 2022-23

IV Semester B.Sc., Zoology Core Course Content

Course Title: IMMUNOLOGY, GENE TECHNOLOGY AND HISTOLOGY	CourseCredits: 4
Course Code: ZO 422	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 4 hrs. self-study)	Duration of ESA: 3 Hours
Formative Assessment Marks: 40	SummativeAssessmentMarks: 60

Course outcomes:

The student at the completion of the course will learn:

- To develop an understanding of the basics in Immunology.
- To learn the basics of the Antigen-Antibody reactions.
- To understand the different immunological reactions.
- To understand the various functional components of Histology.
- To explore the complex network of the various functional components of different tissues.
- To comprehend the various tools and types involved in Gene Technology.

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

Course Outcomes (COs) / Program Outcomes (POs)	CC T1	CC2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10
I Core competency	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	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

UNITS	Part A: IMMUNOLOGY	
1	INTRODUCTION TO THE IMMUNE SYSTEM	5 HRS
1.1	<ul style="list-style-type: none"> • General concepts of the immune system • Innate and adaptive immunity • Inflammation - general properties • Structure, properties and functions of the immune cells & organs 	
1.2	<ul style="list-style-type: none"> • Hematopoiesis • T and B-lymphocytes, NK cells, Monocytes and macrophages • Neutrophils, eosinophils and basophils • Mast cells and dendritic cells (Self-study) 	
1.3	Organs of the Immune System - Thymus and bone marrow, spleen, Lymph Node, Small Intestine and Liver (Peyer's patches and Kupffer cells)	
2	ANTIGENS AND ANTIBODIES	9 HRS
2.1	Antigens and haptens: Properties (foreignness, molecular size, heterogeneity)	
2.2	<ul style="list-style-type: none"> • B and T cell epitopes • T - dependent and T - independent antigens 	
2.3	<ul style="list-style-type: none"> • Major histocompatibility gene complex • Organization of MHC I & II, APC's. • Structure and cellular distribution of HLA antigens 	
2.4	<ul style="list-style-type: none"> • Antibodies: Structure, function and properties of the antibodies • Different classes and biological activities of antibodies • Antibody as B cell receptor • Antigenic determinants on antibodies (isotype, allotype and idiotype) 	
2.5	Genesis of antibody variability- VDJ Model	
2.6	Hybridoma technology - monoclonal antibodies (Self-study) and abzymes	
2.7	Introduction to antibody engineering.	
3	IMMUNITY	7 HRS
3.1	<ul style="list-style-type: none"> • Humoral Mediated: Plasma B cells (B - lymphocytes) • Antibody mediated (IgG, IgM, IgA, IgD and IgE) with examples 	
3.2	<ul style="list-style-type: none"> • Cell Mediated: Cell types (CTLs, NK cells, macrophages and T_CT_H cells) • Effectors mechanisms and effectors molecules of cell mediated reactions 	
3.3	Assessment of cell-mediated cytotoxicity	
3.4	Cytokines - properties and <u>functions of interleukins (IL)</u> (Self-study)	
3.5	Hypersensitivity: Types and mechanism of hyper-sensitive reactions	
3.6	<ul style="list-style-type: none"> • Regulation and modulation of immune response • A general account - Adjuvants, tolerance, immunopotential and immunosuppression 	
4	AUTOIMMUNITY	5 HRS

4.1	<ul style="list-style-type: none"> • Mechanisms of induction of organ specific (Hashimoto's thyroiditis, autoimmune anemia, Goodpasture's syndrome, IDDM) • Autoimmune Encephalitis and systemic autoimmune diseases (Self-study) 	
4.2	<ul style="list-style-type: none"> • Transplantation immunology: Types of grafts • Immunologic basis of graft rejection, • Immunosuppressive therapy and transplants to immunologically privileged sites 	
4.3	<ul style="list-style-type: none"> • Immunity and tumors: tumor antigens (TSTA and TAA) • Immune response to tumors • Tumor evasion of the immune system and Immunotherapy for tumors 	
5	CLINICAL IMMUNOLOGY	2 HRS
5.1	Immunity against viral, bacterial and parasitic infections	
5.2	Vaccines: Types and uses - Immunization schedule for children (Self-study)	
5.3	Prevention of postnatal diseases: tetanus, diphtheria, whooping cough, cholera, yellow fever, measles and AIDS	
	Part B: GENE TECHNOLOGY	13 HRS
6	INTRODUCTION	
	<ul style="list-style-type: none"> • Introduction to genetic engineering - Tools in genetic engineering • DNA manipulative enzymes • Restriction endonucleases types and applications • DNA Ligation 	2hrs
7	CLONING	
7.1	Cloning vectors and Host: Plasmid (pBR322) Bacteriophage (λ phage), <i>E. coli</i> and its role in genetic engineering	3hrs
7.2	Basic principles of gene cloning strategies - Transformation techniques: CaCl_2 mediated Transformation, Microinjections, Electroporation and Liposome mediated transfer.	4hrs
8	Introduction to Crispr-Cas9, Production of human Insulin	2hrs
9	Application and Ethics - Applications of gene cloning and Ethics in Genetic Engineering (Self-study): Applications of gene cloning in Medicine (Gene therapy).	2hrs
	Part C: HISTOLOGY	15 hrs
10	Histological Structures of Mammalian Organs - Tongue, Stomach, Small Intestine, Liver, Pancreas, Thyroid (Self-study), Spleen, Kidney, <u>Pituitary</u> (Self-study), Adrenals, Testes and Ovary	

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1. Prescott, Harley and Klein's, 2008. Microbiology, 7th edition, Tata McGraw Hill international edition, Page 1-1086.
2. David, Brostoff and Roitt, 2006. Immunology, 7th Ed., Mosby & Elsevier Publishing, Canada, USA.
3. C.VRao, 2005. Immunology, 2nd edition, Narosa Publishing House, New Delhi.
4. Roitt, M and Peter J. Delves, 2005. Essential immunology, 10th Edition, Blackwell, USA.
5. Richard A. Goldsby, Thomas j. Kindt, Barbara A. Osborne, Janis Kuby, 2003. Immunology, W.H. Freeman, NY.
6. Raj Khanna, 2011. Immunology, Oxford University press, New Delhi.
7. Abul K Abbas, Andrew K. Litchman and Jorden S. Pober, 2003.
8. Cellular and Molecular Immunology, 3rd Edition, W.B. Saunders, Philadelphia
9. Clark. John wiley and Sons, W. The Experimental Foundations of Modern Immunology, New York.
10. Lichtman, A. and Pober, W.B. Cellular and Molecular Immunology by Saunders Company, Philadelphia.
11. Brown, T.A. 2000, Gene Cloning, fourth edition, Chapman and Hall Publication, USA.
12. Lewin B., 2000, Genes VII, Oxford University Press, Oxford, U.K.
13. Old R.W. and Primrose S.B., 1996, Principles of Gene Manipulations, Blackwell Science Publications, London.
14. SandhyaMitra, 1996, Genetic Engineering, Mac Millar India Ltd., New Delhi.
15. Symonds N., A. Toussaint, P. Van De Putte, M.M. Howe, 1987, Phage Mu. Cold Spring harbor Laboratory. 47
16. Watson, J.D., N.H.Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, 1998, Molecular Biology of the Gene, fourth edition, The Benjamin/Cummings Publishing Company Inc., Tokyo.
17. Winnaker E.L., 1987, From Gene to Clone: Introduction to Gene Technology, VCH Publications, Weinbem Federal Republic German

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

QUESTION PAPER PATTERN

Semester 4

ZO421- Immunology, Gene Technology and Histology

Questions	With choices	Total mark
1 mark	10 x 1	10
5 mark	4 x 5(6 questions)	20
10 mark	3 x 10 (4 questions)	30
TOTAL		60

Zoology Semester IV: Core Course Lab Content

Course Title/Code: Immunology, Gene Technology and Histology	CourseCredits: 2
Course Code: ZO 4P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	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 understand:

- Basics of antigen-antibody reactions.
- 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 vaccination and fluorescent staining techniques.
- Know the uniqueness of ELISA Technique.

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

Course Outcomes (COs) / Program Outcomes (POs)	CC P1	CC2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

List of labs to be conducted	10 Units
Lab Course Content:	
1. Antigen-Antibody reactions – agglutination - Blood grouping: (A, B, O and AB)	1 unit
2. Precipitation – Gel diffusion and Double Diffusion (ODD)	1 unit
3. Virtual Dissection to locate primary and secondary lymphoid organs (any vertebrate)	1 unit
4. Observation of permanent slides of lymphoid organs / tissues	1 unit
5. ELISA-demo	1 unit
6. Visit to different Institutes and departments related to immunology and vaccine producing laboratories, Diagnostic centers	1 unit
7. Histological Structures of Mammalian Organs - Tongue, stomach, small intestine, liver, pancreas, thyroid, spleen, kidney, pituitary, adrenals, testes and ovary.	3 units
8. Restriction and Digestion of Plasmid DNA	1 unit
Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	

Course Outcomes and Course Content

under New Education Policy – Year 2023-24

V Semester B.Sc.,

Zoology Core Course

Content

Course Title/Code: NON-CHORDATES AND ECONOMIC ZOOLOGY	Course Credits: 3
Course Code: ZO5123	L-T-P per week: 3-0-0
Total Contact Hours: 45 (39 hours teaching + 6 hrs. self-study)	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

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:

- The classification of organisms.
- Phylogeny and evolution of organs and organ systems.
- The basic principle of life, how complex organisms have evolved from simpler ones
- A thorough understanding of useful non-chordates
- Understanding the variety of life forms
- Indirect methods of development through larval stages.

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 1	CC 11	CC 12	CC 13
I Core competency	X	X	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	X	X	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.

UNITS	PART A-NON-CHORDATES	
1	INTRODUCTION	3 HRS
1.1	<ul style="list-style-type: none"> • Systematics • Binomial and Trinomial nomenclature • International rules of Zoological nomenclature (IUCN) 	1 hr
1.2	<p>A brief account of the criteria employed in classification</p> <ul style="list-style-type: none"> • Organization, symmetry, Germ layers • Types of coelomic cavities - Eucoelom and Pseudocoelom • Metamerism and Cephalization • Modern taxonomic methods 	2 hr
2	ANIMAL LIKE PROTISTS	2 HRS
2.1	<ul style="list-style-type: none"> • <u>Distinguishing features and classification up to classes</u> • <u>Special emphasis on class characteristics with suitable examples (Self-study)</u> 	1 hr
2.2	<p>Reproduction in Protozoa:</p> <ul style="list-style-type: none"> • Asexual reproduction: Binary fission, Multiple fission, Plasmotomy, budding • Sexual reproduction: Conjugation in <i>Paramecium caudatum</i> 	1 hr
3	PORIFERA	3 HRS
3.1	<ul style="list-style-type: none"> • Distinguishing features and classification, up to classes • Special emphasis on class characteristics with suitable examples 	1 hr
3.2	<ul style="list-style-type: none"> • Canal system - Types, canal system in Sycon and functions • Skeleton in Sponges - Spicules and spongin fibres. 	2 hrs
4	CNIDARIA	3 HRS
4.1	<ul style="list-style-type: none"> • Distinguishing features and classification, up to classes • Special emphasis on class characteristics with suitable examples 	1 hr
4.2	<ul style="list-style-type: none"> • External features and life cycle of <i>Aurelia</i> • Corals- types of corals and theories of coral reef formation - Daly's theory 	2 hrs
5	HELMINTHES	3 HRS
5.1	<ul style="list-style-type: none"> • Distinguishing features and classification, up to classes • Special emphasis on class characteristics with suitable examples 	1 hr
5.2	Regeneration in Planaria (<i>Dugesia</i>) - Child's axial gradient theory	1 hr
5.3	Parasitic adaptations in tapeworm (Self-study)	1 hr
6	ANNELIDA	4 HRS
6.1	<ul style="list-style-type: none"> • Distinguishing features and classification, up to classes • Special emphasis on class characteristics with suitable examples 	1 hr
6.2	<ul style="list-style-type: none"> • <i>Nereis</i> and <i>Heteronereis</i>- Atoke and epitoke • Trochophore larva and its phylogenetic significance 	1 hr

6.3	Earthworm: morphology and digestive system	2 hrs
7	ARTHROPODA	4 HRS
7.1	<ul style="list-style-type: none"> • Distinguishing features and classification, up to classes • Special emphasis on class characteristics with suitable examples 	1 hr
7.2	Unique features and systematic position of <i>Peripatus</i> (Self-study)	1 hr
7.3	Larval forms in crustaceans-Nauplius, Metanauplius, Protozoa, Zoea, Mysis	1 hr
7.4	Metamorphosis- Types and neuroendocrine regulation	1 hr
8	MOLLUSCA	4 HRS
8.1	<ul style="list-style-type: none"> • Distinguishing features and classification, up to classes • Special emphasis on class characteristics with suitable examples 	1 hr
8.2	<ul style="list-style-type: none"> • Freshwater mussel- externals, C.S. of shell and respiratory system • Torsion and coiling in gastropoda 	2 hrs
8.3	Structure and function of foot in – <i>Neopilina, Chiton, Mytilus, Pila, Dentalium</i> and Octopus	1 hr
9	ECHINODERMATA AND MINOR PHyla	4 HRS
9.1	Distinguishing features and classification, up to classes Special emphasis on class characteristics with suitable examples	1 hr
9.2	Starfish - Water vascular system	1 hr
9.3	Bipinnaria larva and its phylogenetic significance (Self-study)	1 hr
9.4	<ul style="list-style-type: none"> • List of minor phyla with examples • Salient features and affinities of Rotifers 	1 hr
PART-B ECONOMIC ZOOLOGY		
10	APICULTURE, SERICULTURE, AQUACULTURE	6 HRS
10.1	<i>Apiculture</i> : Honey bees-different species, social organization, life cycle, structure of bee hives, methods of bee keeping, diseases and products of apiculture	2 hrs
10.2	<ul style="list-style-type: none"> • <i>Sericulture</i>: Different species, life cycle of <i>Bombyx mori</i>, products, diseases, methods of sericulture • <i>Lac culture</i>- types and products • <i>Vermiculture</i> - types of earthworms based on habit, steps involved 	2 hrs
10.3	<i>Aquaculture</i> <ul style="list-style-type: none"> • Types (Shell, fin and plankton culture) • Mono- and Composite culture and induced breeding of fishes • <u>Ornamental fishes- examples</u> • <u>Diseases: symptoms and control</u> • <u>Aquaponics (Self-study)</u> 	2 hrs

11	PESTS OF CROPS AND STORED PRODUCTS	2 HRS
11.1	<ul style="list-style-type: none"> • Pests of stored products- Rice weevil, Pulse beetle, and Rice moth –biology, damage and management. • Common pests in urban gardens • Pests of crops- Cereals, pulses, fruits, vegetables and cash crops- biology, damage and management of major pests. 	2 hrs
12	VECTOR BIOLOGY AND HUMAN PARASITES	5 HRS
12.1	<ul style="list-style-type: none"> • Vector biology: Meaning and types of vectors, Diseases transmitted by mosquito (Dengue, malaria, yellow fever, JE), snail and bat. 	1 hr
12.2	<ul style="list-style-type: none"> • Human Parasites: Parasitic protozoans in man -Occurrence, disease caused, mode of transmission, symptoms and preventive measures of <ul style="list-style-type: none"> a) <i>Entamoeba histolytica</i> b) <i>Trypanosoma gambiense</i> c) <i>Leishmania donovoni</i> d) <i>Plasmodium vivax</i> • Parasitic nematodes – Occurrence, mode of infection, disease caused and control measures of the following: <ul style="list-style-type: none"> a) <i>Ancylostoma duodenale</i> b) <i>Enterobius vermicularis</i> c) <i>Wuchereria bancrofti</i> d) <i>Ascaris lumbricoides</i> 	2 hrs 2 hrs
13	POULTRY AND DAIRY	2 HRS
13.1	<i>Dairy Industry</i> - breeds, products, challenges (Self-study)	1 hr
13.2	<i>Poultry farming</i> - breeds, products, challenges	1 hr

REFERENCE BOOKS

1. A GENERAL ZOOLOGY OF THE INVERTEBRATES **Carter GS.**
2. A MANUAL OF ZOOLOGY. **Ekambarnath Ayyar and Anantha Krishnan**
3. A STUDENT TEXTBOOK OF ZOOLOGY. **Sedgewick.**
4. AN INTRODUCTION TO THE INVERTEBRATES. **Janet Moore**, revised
Cambridge University Press, 2006 ISBN 1139458477, 9781139458474
5. ATLAS OF INVERTEBRATE ANATOMY. **Donald Thomas Anderson.** UNSW Press, 1996. ISBN 0868402079, 9780868402079
6. BIOLOGY OF ANIMALS. Vol 1. **Adhikari, Sinha and Ganguli.** New central book agency, Calcutta.
7. BIOLOGY OF INVERTEBRATES. **Hickman CP.**
8. BIOLOGY OF NON CHORDATES. **Nigam H.C. Naginchand S L** and Co. Jallander.
9. BIOLOGY OF NON-CHORDATES. **Fatik Baran Mandal.** PHI Learning Pvt. Ltd., 2017. ISBN 9387472019, 9789387472013
10. BIOLOGY OF THE INVERTEBRATES. **Cleveland Pendleton Hickman C.** V. Mos Co., 1967
11. ECONOMIC ZOOLOGY. **G.S. Hubhla & V.B. Upadhyaya Hyman L H**

12. INTEGRATED PRINCIPLES OF ZOOLOGY. **Hickman CP**,
13. INVERTEBRATE ZOOLOGY Vol I - Vol VI. **L H Hyman** McGraw Hill Book Company
14. INVERTEBRATE ZOOLOGY. **Barnes**, Hault Saunders, 4th Edition.
15. INVERTEBRATE ZOOLOGY. **Dhami & Dhami**.
16. INVERTEBRATE ZOOLOGY. **Jordan and Verma**. S Chand & Co.,
17. INVERTEBRATE ZOOLOGY. **Meclisten**. Oxford Publishing house.
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19. INVERTEBRATES STRUCTURE AND FUNCTION. **Barrington**. ELBS
20. INVERTEBRATES. **Brown, Frank A** ed, Daya Books, 2002. ISBN 8176220744, 9788176220743
21. INVERTEBRATES. **Encyclopedia Britannica**, Inc., Encyclopedia Britannica, Inc., 2012 ISBN 1615358250, 9781615358250
22. INVERTEBRATES. **Eugene N. Kozloff**. Saunders College Pub., 1990. ISBN 0030462045, 9780030462047
23. INVERTEBRATES. **Richard C. Brusca**. Sinauer, 2016. ISBN 1605353752, 9781605353753
24. INVERTEBRATES. Vol.1. **Kotpal**. Rastogi publications.
25. INVERTEBRATES: PROTOZOA TO ECHINODERMATA. **Ashok Verma**. Alpha Science International, 2005 ISBN 1842652001, 9781842652008
26. PARASITIC PROTOZOA. Baker JR,
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Pedagogy: Written Assignment/Presentation/Project / Term Papers/ Seminar

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

Question Paper Pattern

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (5 questions)	30
TOTAL		60

PAPER CODE ZO5P1

ZOOLOGY

SEMESTER-V

PRACTICAL V

ZO5P1: NON-CHORDATES AND ECONOMIC ZOOLOGY

Zoology Core Lab Course Content

Course Title: Non-Chordates and Economic Zoology	
Course Credits:2	
Course Code: ZO 5P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 4 Hours
Formative Assessment Marks: 25	Summative Assessment Marks: 25

Course Outcomes (COs):

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

- Describe the diversity of life, general rules of animal taxonomy, symmetry, germ layers, coelomic cavities, metamerism and cephalization.
- To identify and understand the larval forms of non-chordates.
- To outline the life cycle of parasites and their impacts on health.
- To identify the appendages of prawn and a thorough understanding of its body plan.

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	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analyticalreasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

Lab Course Content

List of labs to be conducted	10 Units
Lab course content	
1. Protozoa: <i>Euglena, Entamoeba, Trypanosoma, Plasmodium, Paramecium</i> – w.m., /conjugation, <i>Vorticella, Noctiluca</i>	1 unit
2. Porifera & Cnidaria: <i>Sycon, Hyalonema, Euplectella, Hydra, Physalia, Aurelia</i> , Ephyra larva, Sea anemone and T. S. of sea anemone, Corals- <i>Fungia, Astrea, Alcyonium</i> Slides: Spicules and Gemmule	1 unit
3. Platyhelminthes & Nematoda: <i>Planaria</i> , Tapeworm- w. m. scolex, Liver fluke- w. m. Male roundworm, T. S. of male roundworm, Female roundworm, T. S. of female roundworm	1 unit
4. Annelida: <i>Nereis</i> , Parapodium, <i>Heteronereis, Aphrodite, Arenicola, Sabella, Chaetopterus</i> , Trochophore larva, Earthworm (T.S. passing through the Typhlosolar region).	1 unit
5. Arthropoda: <i>Peripatus</i> , Centipede, Millipede, <i>Limulus, Apis</i> , Silk moth Slides: Nauplius larva, Mysis Larva	1 unit
6. Mollusca: <i>Chiton, Nautilus</i> , Octopus, <i>Sepia</i> , Cuttle bone, Pearl Oyster, <i>Dentalium Cypraea, Haliotis</i>	1 unit
7. Echinodermata: Star fish, Brittle star, Sea lily, Sea cucumber, Sea urchin, Cake urchin Slides: Pedicellaria, Bipinnaria larva.	1 unit
8. Extraction and isolation of nematodes by Baermann's funnel technique	1 unit
9. Mounting of antennary gland and appendages of Prawn-	1 unit
10. Study of digestive and nervous system of Prawn	1 unit

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	25
Practical Internal Assessment	25
Total	50

Course Outcomes and Course Content

Under New Education Policy – Year 2023-24

V Semester B.Sc.,

Zoology Core Course

Content

Course Title/Code: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT AND CONSERVATION	Course Credits: 03
Course Code: ZO 5223	L-T-P per week: 3-0-0
Total Contact Hours: 45 (39 hours teaching + 06 hrs self-study)	Duration of ESE: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

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. To find career opportunities in the field of ecology and wildlife.
2. To be instruments of change by involving, educating and creating awareness among general public about the need to conserve biodiversity and our environment.

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
I Core competency	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X
V Team work	X	X	X	X	X	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 V

UNITS	PART A: ENVIRONMENTAL BIOLOGY	35 HRS
1	Ecosystems and habitat ecology	9 HRS
1.1	<i>Introduction</i> <ul style="list-style-type: none"> • Scope and branches of ecology, • Components of ecosystem (abiotic and biotic) • Ecotone and edge effect, weather and climate 	2 hrs
1.2	<i>Habitat and Niche:</i> <ul style="list-style-type: none"> • Concept (types with examples, Aquatic and terrestrial, micro and macro; exobiology). • Niche: types, competitive exclusion (<i>Paramecium Aurelia</i> and <i>P. caudatum</i>) and resource partitioning with examples. 	2 hrs
1.3	<i>Ecosystems:</i> <ul style="list-style-type: none"> • Aquatic ecosystems: Freshwater – lentic & lotic systems. <u>Type study: Pond ecosystem (Self study)</u>. Marine ecosystem – zonation of the sea and ecological classification of marine biota. Estuary and wetlands. • Terrestrial ecosystems: Types and general features of terrestrial biomes, soil profile and soil organisms. 	5 hrs
2	Ecological energetics	6 HRS
2.1	<i>Energy flow in ecosystem:</i> <ul style="list-style-type: none"> • Laws of thermodynamics and energy flow models. • Food chain and food web • Ecological pyramids types with examples (Selfstudy) 	2 hrs
2.2	<i>Productivity:</i> <ul style="list-style-type: none"> • Primary & secondary productivity. • Methods of measuring primary productivity – Harvest, Dark and light bottle, Carbon dioxide method, Chlorophyll and Bomb calorimetry. 	2 hrs
2.3	<i>Bio-geo chemical cycles:</i> <ul style="list-style-type: none"> • Definition and types, • Nitrogen cycle, Nutrient Enrichment and Eutrophication. 	2 hrs
3	Ecological factors	5 HRS
3.1	<i>Limiting factors:</i> Liebig's law of minimum and Shelford's law of tolerance and Allen- Bergman effect on size.	2 hrs
3.2	<i>Effects of abiotic factors:</i> <ul style="list-style-type: none"> • Light (Development, photo-periodism, bioluminescence, celestial orientation, pigmentation and Light Pollution (Artificial light pollution at night – ALAN • Temperature on animals (Development, Cyclomorphosis, Metabolism). <u>Poikilotherms and Homeotherms (Self-study)</u>. 	2hrs 1 hr
4	Population and Community ecology	7 HRS

4.1	<i>Population Characteristics:</i> Concept of Density, Natality, Mortality, Dispersion and Age structure.	1 hr
4.2	<i>Population growth:</i> <ul style="list-style-type: none"> • Linear and Exponential. Concept of biotic potential and environmental resistance. • Density dependent and independent growth, r and k selected species. 	2hrs
4.3	<i>Community ecology:</i> <ul style="list-style-type: none"> • Animal associations–Positive (Mutualism, commensalism, proto-cooperation), Negative (Herbivory, Parasitism, Antibiosis, Predation and Competition) with relevant examples. • Lotka-Volterra model. 	2 hrs
4.4	<i>Ecological succession:</i> Meaning, types (primary and secondary), stages with reference to Hydrosere.	2hrs
5	Global change ecology	8 HRS
5.1	<i>Environmental Pollution and Control</i> <ul style="list-style-type: none"> • Water Pollution (Self study) • Greenhouse effect and global warming, climate change, IPCC 	3 hrs
5.2	<i>Eco-toxicology and Environmental biotechnology:</i> <ul style="list-style-type: none"> • Meaning, dose, response, bio-magnification, bioaccumulation, biotransformation, endocrine disruptors, Concept of bioassay, toxicity measures-LC 50 and LD 50, • EIA and bioremediation -Types, advantages and disadvantages with examples. 	3 hrs
5.3	<i>Disasters:</i> <ul style="list-style-type: none"> • Meaning, Types (Natural and Man-made), • Causes for occurrence of disaster and management 	2 hr
PART B: WILDLIFE MANAGEMENT AND CONSERVATION		10 HRS
6.1	<i>Wildlife ecology</i> <ul style="list-style-type: none"> • Definition of Wildlife: Biogeographic profile of India and India as a mega diversity country. Biodiversity Hotspots in India. Endemic species in India. Ecosystem services of wildlife • Keystone, Umbrella and Flagship species, indicator species, invasive/exotic species • IUCN categories and criteria with Indian examples. Red and Green data book (Self-study) • Link between biodiversity and climate change. • Zoonoses : 	4 hrs
6.2	<i>Human dimensions of wildlife conservation</i> <ul style="list-style-type: none"> • Sacred Grooves – Corridors – Citizen science-People participation in Conservation. Community Forests Eco-Restoration and Ecotourism, • Captive breeding programs, population reintroductions and translocations • Human-Wildlife Conflicts and Mitigation. • Environmental movements: Chipko and Appiko movements 	3 hrs
6.3	<i>Conservation laws, policies and management</i> <ul style="list-style-type: none"> • Threats and measures to preserve Biodiversity <u>Protected areas: in situ & ex situ conservation methods</u> – National Parks, Wildlife Sanctuaries, 	3 hrs

	<p><u>Conservation Reserves, Community Reserves (Self-study)</u></p> <ul style="list-style-type: none"> • Wildlife (Protection) Act; Environment (Protection) Act; CITES. Conservation genetics. • National Conservation Authorities (National Biodiversity Authority and National Tiger Conservation Authority), and International Conventions viz., RAMSAR Convention, Convention on Biological Diversity. • Eco-sensitive Zones, Wetlands of National Importance, Project Elephant, Important Bird Areas, Coastal and Marine Biodiversity 	
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1. Collin R, Townsend, Harper J L, and Michael Begon. 2000 Essentials of ecology. (Blackwell Sci. Comp.) pp 552.
2. Odum E P 1971 Fundamentals of ecology (WB Saunders Co.) Pp 574.
3. Pandey B. N. Ecology and Animal Behavioural-.4.:; Tata McGraw-Hill Education.
4. Sanjiv Chattopadhyay. 2014 Evolution adaptation and ecology; books and allied private limited
5. La Grega and Evans 2015. Hazardous waste management; scientific international distributors and publishers.
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7. Nandini, N. (2019). A text book on Environmental Studies (AECC). Sapna Book House, Bengaluru.
8. Rachel Carson. (2002). Silent spring. Houghton Mifflin Harcourt.

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

Question Paper Pattern

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (5 questions)	30
TOTAL		60

PAPER CODE ZO 5P2

ZOOLOGY

SEMESTER-V

PRACTICAL VI

ZO5P2: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT AND CONSERVATION

Zoology Core Lab Course Content

Semester V

Course Title: ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT AND CONSERVATION	Course Credits: 02
Course Code: ZO 5P2	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 4 Hours
Formative Assessment Marks: 25	Summative Assessment Marks: 25

Course Outcomes (COs):

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

- Learn to estimate different chemical component of water and soil
- Study zooplankton diversity
- Understand ecological adaptations and interaction of animals.
- Learn different technique and tools used in diversity studies

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

Course Outcomes (COs) / Program Outcomes (POs)	CC P1	CC2	CC 3	CC 4	CC 5	CC 6	CC 7	CC 8	CC 9	CC 10	CC 11
I Core competency	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

Total Number of Practicals	10 Units
Lab Course Content	
I. ENVIRONMENTAL BIOLOGY EXPERIMENTS	06 Units
<ol style="list-style-type: none"> 1. Estimation of Salinity 2. Estimation of Dissolved oxygen 3. Estimation of Organic matter 4. Estimation of Calcium carbonate content in soil 5. Estimation of Phosphate and Nitrates in water sample 6. Studies on Turbidity (Seechi disc), pH (pH pen) and Zooplankton (Sedgewick rafter) in water 	
II. ECOLOGICAL ADAPTATIONS	02 Units
<ol style="list-style-type: none"> 1. Fossorial forms: Dentalium and Balanoglossus 2. Sedentary forms: Barnacle and Ascidia 3. Colonial forms: Honey bees and termites 4. Parasitism: Sacculina on crab 5. Mutualism: Hermit crab with sea-anemone 6. Mimicry and camouflage-stick insect, leaf insect and chameleon. 	
III. FIELD ECOLOGY	02 Units
<ol style="list-style-type: none"> 1. Applications of Camera traps, binoculars, GPS, sound recorders 2. Identification of indirect evidences: pugmark (tiger, leopard and wild dog) and excrement (scat, pellet, dung, droppings) (Clay models) 3. Biodiversity indices: Simpson's index 	
IV. Report submission (Any one)	
<ul style="list-style-type: none"> • Survey of floral and faunal diversity in an area. • Describe the environmental problem of your locality and suggest a remedy • To make an audit of the electrical energy consumption by various household appliances/ Carbon footprint • Plastic and recycle initiatives in SJU campus 	

Pedagogy: Lectures, Presentations, videos, Virtual Labs, Assignments, Tests, Individual or group Field oriented Project Report on or visit to a research institute.

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	20 + 05 (project report) = 25
Practical Internal Assessment	25
Total	50

QUESTION PAPER PATTERN

Semester 5

ZO 5P2 - ENVIRONMENTAL BIOLOGY, WILDLIFE MANAGEMENT AND CONSERVATION

Duration: 3 hours

Max Marks: 25

1. Major experiment	07
2. Minor experiment	04
3. Spotters /Problem to solve	3 X 3 = 09
4. Project report submission	5

Course Outcomes and Course Content

under New Education Policy – Year 2023-24

VI Semester B.Sc.,

Zoology Core Course

Content

Course Title/Code: CHORDATES AND COMPARATIVE ANATOMY	Course Credits: 03
Course Code: ZO 6123	L-T-P per week: 3-0-0
Total Contact Hours: 45 (39 hours teaching + 06 hrs self study)	Duration of ESE: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

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:

- To learn the origin of chordates
- To learn the general characters of chordates
- To understand the chordate evolutionary tree
- To study peculiar features of each class of chordates
- To study evolution of different anatomical structures in different classes of chordates

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	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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.

UNITS	Part A: CHORDATES	35 HRS
1	GENERAL FEATURES OF CHORDATES	7 HRS
1.1	<ul style="list-style-type: none"> • Salient features of Chordates and classification, Origin of Chordates • A brief account of Barrington's Combined theory 	2 hrs
1.2	Hemichordata <ul style="list-style-type: none"> • Salient features of Hemichordates • Structure of Tornaria larva and its significance 	1 hr
1.3	Cephalochordata <ul style="list-style-type: none"> • Salient features of Cephalochordates • Amphioxus- External morphology, Feeding and digestion 	2 hrs
1.4	Urochordata <ul style="list-style-type: none"> • Salient features of Urochordates • <u>Ascidian tadpole and retrogressive metamorphosis (Self study)</u> 	2 hrs
2	AGNATHA	2 HRS
2.1	<u>Salient features of Agnatha, Classification up to classes (Self study)</u>	1 hr
2.2	Ammocoetes larva- structure and its phylogenetic significance	1 hr
3	PISCES	3 HRS
3.1	<ul style="list-style-type: none"> • General characters – with emphasis on the primary aquatic adaptations • Differences between cartilaginous & bony fishes 	1hr
3.2	Shark: Circulatory system	1 hr
3.3	Interesting features and discontinuous distribution of dipnoi fishes	1 hr
4	AMPHIBIA	7 HRS
4.1	<ul style="list-style-type: none"> • General characters • Classification up to orders • <u>A brief account of the origin of amphibian (Self study)</u> 	2 hrs
4.2	Frog (Rana sp.) – A brief account of digestive, respiratory, circulatory and urinogenital system	4 hrs
4.3	<ul style="list-style-type: none"> • Neuro-endocrine control of metamorphosis in Amphibia • Pedogenesis and Neoteny 	1 hr

5	REPTILIA	5 HRS
5.1	<ul style="list-style-type: none"> • General characters with special reference to terrestrial adaptations • Classification with examples 	1 hr
5.2	<ul style="list-style-type: none"> • Brief account on fossae in reptiles • Living fossil - Sphenodon 	2 hrs
5.3	<u>Mesozoic radiation – Dinosaurs, Pterosaurs, Ichthyosaurs and Mammal-like reptiles (Self study)</u>	1 hr
5.4	General adaptations in snakes including poison apparatus, venom - types	1 hr
6	AVES	4 HRS
6.1	<ul style="list-style-type: none"> • General characteristics and classification of Aves • Differences between Ratitae and Carinatae 	1 hr
6.2	<ul style="list-style-type: none"> • Aerodynamics of flight • Adaptations for aerial mode of life - anatomical and physiological, mechanism of Gas exchange 	2 hrs
6.3	Structure of feather and its types (Flight feathers, Contour feathers, Down feathers and Filoplume)	1 hr
7	MAMMALS	9 HRS
7.1	<ul style="list-style-type: none"> • General characteristics of Mammals • Classification with examples 	1 hr
7.2	<ul style="list-style-type: none"> • Origin of Mammals • Salient features of the following: Prototheria, Metatheria, Insectivora, Carnivora, Chiroptera, Perissodactyla, Artiodactyla, Cetacea and Proboscidea 	3 hrs
7.3	Adaptive radiation as illustrated by changes in limb structure and types of locomotion	2 hrs
7.4	<u>Salient features and outline classification of primates with examples (Self study)</u>	1 hr
7.5	Integument and its derivatives in vertebrates (epidermal glands, epidermal scales and scutes, horns, hair, claws, nails and hoofs)	2 hrs
8	Sensory organs in vertebrates: Olfactory, gustatory, photoreceptors and statoacoustic organs (lateral line system; electroreception in fishes; echolocation in Bats)	3 HRS
Part B: COMPARATIVE ANATOMY		5 HRS
9	<ul style="list-style-type: none"> • Respiratory system in vertebrates (gills, swim bladders, lungs and ducts) 	2 hrs
10	<ul style="list-style-type: none"> • <u>Evolution of aortic arches in vertebrates (Self study)</u> 	1 hr
11	<ul style="list-style-type: none"> • Excretory system in vertebrates 	2 hrs

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

Question Paper Pattern

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (5 questions)	30
TOTAL		60

PAPER CODE ZO 6P1
ZOOLOGY
SEMESTER-VI
PRACTICAL VII
ZO 6P1: CHORDATES AND COMPARATIVE ANATOMY

Zoology Core Lab Course Content

Semester VI

Course Title: CHORDATES AND COMPARATIVE ANATOMY	Course Credits: 02
Course Code: ZO 6P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	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:

- Salient features of representative animals from each class of chordates
- Able to differentiate different types of scales of fishes
- Understand the importance of feet and beak modifications in birds
- Understand the differences of similar anatomical structures in different classes of chordates

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	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analyticalreasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

Total Number of Practicals		10 Units
Lab Course Content		
01	I. Hemichordates Balanoglossus – w.m. II. Urochordata and Cephalochordates Ascidia, Ascidian tadpole and Amphioxus	01 Unit
02	Vertebrata I. AGNATHA Petromyzon, Myxine and Ammocoetes larva II. FISHES <ul style="list-style-type: none"> • Electric Ray, Saw fish, Sucker fish, Globe fish, Eel- Muraena, Hippocampus, Flat fish • Accessory respiratory organs in Anabas, Clarias and Saccobranthus 	01 Unit
03	I. AMPHIBIANS Duttaphrynus, Hyla, Ambystoma, Axolotl, Ichthyophis, Necturus, Salamander II. REPTILES <ul style="list-style-type: none"> • Draco, Phrynosoma, Varanus, • Carapace and plastron • Venomous and non-venomous snakes- Viper, Cobra, Krait, Sea snake, rat snake 	01 Unit
04	I. AVES Beak and feet modifications of parrot, duck, eagle and crow II. MAMMALS Ant eater, Loris, Mongoose and Bat	01 Unit
05	Study of morphology of gill apparatus in fish (discarded fish head obtained from market)	01 Unit
06	Mounting of cycloid scales and study of different morphological features (carps)	01 Unit
07	Comparative anatomy of brain, heart, skin and skull of fish, amphibian, reptile, bird and mammal	04 Units
	Project report (any one) 1. Visit nearby zoological garden report the diversity of vertebrates 2. Visit nearby water ecosystem, identify and report different bird species 3. Visit nearby aquarium and report on diversity of fishes	

Pedagogy: Lectures, Presentations, videos, Virtual Labs, Assignments, Tests, Individual or group Field oriented Project Report on or visit to a research institute.

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	20 + 05 (project report) = 25
Practical Internal Assessment	25
Total	50

QUESTION PAPER PATTERN

Semester 6

ZO6P1- CHORDATES AND COMPARATIVE ANATOMY

1. Identify and comment on the given spotters A, B, C and D 4X 3 = 12 marks
2. Comment on the ecological adaptations of F and G 2X 2 = 4 marks
3. Mount the given scale report any two morphological features 04 marks
4. Project report 05 marks

Course Outcomes and Course Content

under New Education Policy – Year 2023-24

VI Semester B.Sc.,

Zoology Core Course

Content

Course Title/Code: DEVELOPMENTAL AND EVOLUTIONARY BIOLOGY	Course Credits: 3
Course Code: ZO 6223	L-T-P per week: 3-0-0
Total Contact Hours: 45 (39 hours teaching + 6 hrs. self-study)	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course Outcomes (COs):

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

- To understand basic tenets of developmental and evolutionary biology.
- To understand the processes involved in development of model organisms.
- To provide knowledge explaining the basic requirements for evolution to occur, forces by which evolution occurs.
- Define and explain species concepts and processes that create species

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	CC 12
I Core competency	X	X	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	X	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.

UNITS	PART A- DEVELOPMENTAL BIOLOGY	
1	INTRODUCTION TO DEVELOPMENT	3 HRS
1.1	Theories of development– <ul style="list-style-type: none"> • Preformation theory • Epigenetic theory • Von Baer's theory 	1 hr
1.2	Reproductive patterns: <ul style="list-style-type: none"> • Parthenogenesis (haploid, diploid and artificial) • Asexual (Budding, fission, regeneration) • Sexual (conjugation, oviparity, viviparity and ovoviviparity) (Self-study) 	1 hr 1hr
2	CLEAVAGE	4 HRS
2.1	Types of eggs-based on distribution and quantity of yolk with suitable examples	1 hr
2.2	Cleavage- <ul style="list-style-type: none"> • Types of cleavage planes • Patterns of cleavage • Types of cleavages • Influence of yolk on the process of cleavage • Types based on the amount of yolk with examples 	2 hrs
2.3	Structure and evolutionary significance of a cleidoidic egg with chick's egg as an example.	1 hr
2.4	Cleavage pattern in <i>Amphioxus</i> , frog and chick embryo	1 hr
3	DESCRIPTIVE EMBRYOLOGY	6 HRS
3.1	<i>Blastula and blastulation</i> : Amphioxus, Frog and Chick <u>Comparative account of the blastula of Amphioxus, Frog and Chick</u> (Self-study)	3 hrs
3.2	<i>Gastrula and Gastrulation</i> : Amphioxus, Frog and chick. Fate map of frog	3 hrs
4	DEVELOPMENTAL GENETICS Egg polarity, Segmentation and Homeotic genes in <i>Drosophila</i> development	2 HRS
5	ORGANOGENESIS	6 HRS
5.1	Organizer phenomena <ul style="list-style-type: none"> • Definition of organizer • Spemann experiments (potencies of gray crescent, the dorsal lip of the blastopore of amphibian gastrula) • Spemann and Mangold transplantation experiment • Chemical nature and structure of organizer 	3 hrs

5.2	<ul style="list-style-type: none"> • Induction–Components, Chain and Reciprocal induction • Competence with reference to development of amphibian eye 	1 hr
5.3	Organogenesis in frog: Neurulation, Notogenesis and Mesogenesis	2 hrs
6	EXTRA-EMBRYONIC MEMBRANES	5 HRS
6.1	Extraembryonic membranes of chick: Formation, structure and functions of Yolk sac, Amnion, Chorion and Allantois	3 hrs
6.2	<ul style="list-style-type: none"> • Placenta: Types based on foetal membranes involved (Self-study), distribution of villi, nature of contact and histology with examples • Placental hormones and their functions 	2 hrs
7	HUMAN DEVELOPMENTAL BIOLOGY	4 HRS
7.1	Role of Gonadotropins, hormones secreted by testes and ovaries (self-study)	1 hr
7.2	Menstrual Cycle and its hormonal control	2 hrs
7.3	Process of fertilization, blastocyst formation and implantation	1 hr
PART-B EVOLUTIONARY BIOLOGY		
8	HISTORY OF LIFE	2 HRS
8.1	<ul style="list-style-type: none"> • Brief history of life through geological time • Major faunal transitions – multicellularity, symbiosis, Cambrian explosion, terrestrialization. 	1 hr
8.2	<ul style="list-style-type: none"> • <u>Origin of life: Haldane-Oparin, Miller-Urey, RNA first (Carl Woese), Mass extinctions</u> (Self-study) 	1 hr
9	THEORIES OF ORGANIC EVOLUTION	4 HRS
9.1	<ul style="list-style-type: none"> • Brief history of evolutionary thought before Darwin: Aristotle's <i>scala naturae</i>, Buffon, Cuvier, and the idea of transformation, William Paley and intelligent design, Lamarck • Darwin-Wallace theory of Natural Selection • Concept of Tree thinking 	2 hrs
9.2	<p><i>Evidences in support of organic evolution</i></p> <ul style="list-style-type: none"> • Dating of fossils: Uranium-lead method, radio-carbon, potassium-argon method • Anatomical, embryological and paleontological 	2 hrs
10	FORCES OF EVOLUTION	3 HRS
10.1	<ul style="list-style-type: none"> • Variation, mutations - types and levels • Overview of Hardy-Weinberg equilibrium • Introduction to Random Genetic drift (Founder and bottleneck effects) • Gene flow and isolation by distance 	1 hr

10.2	<ul style="list-style-type: none"> • Natural Selection: definition, modes (directional, stabilizing, and disruptive) brief overview of case studies - coat color in mice • Sexual Selection: types, inter-and intra-sexual selection • Case studies - Pigmentation, lactose intolerance in humans 	2 hrs
11	MECHANISMS OF SPECIATION	4 HRS
11.1	<i>Overview of speciation and speciation concepts –</i> <ul style="list-style-type: none"> • Biological, phylogenetic species concept • Isolating mechanisms and speciation: reproductive isolation (pre and post-zygotic barriers) and geographic isolation (allopatry, sympatry and parapatry) 	2 hrs
11.2	<u>Adaptive radiation (case studies- Hawaiian Drosophila/honeycreepers, mammals and reptiles) (Self study)</u>	1 hr
11.3	<i>Basics of Phylogenetics</i> <ul style="list-style-type: none"> • How to read Trees, clades, rooted and unrooted trees • Fundamentals of constructing trees 	1 hr
12	ZOOGEOGRAPHY AND MACROEVOLUTION	2 HRS
12.1	<ul style="list-style-type: none"> • Introduction to macro evolution • Plate tectonics and continental drift • Vicariance and discontinuous distribution of animals • Macro evolution case study: overview of co-evolution between bees and angiosperms 	1 hr
12.2	<i>Overview of Human Evolution: Ramapithecus, Ardipithecus, Hominins - Australopithecines - Australopithecus afarensis, A. africanus, Genus Homo (H. habilis, H. ergaster, H. erectus -, H. heidelbergensis - H. neanderthalensis, H. sapiens sediba and H. sapiens sapiens)</i>	1 hr

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1. Balinsky, B.L. 1971 Introduction to Embryology (Saunders College pub.)
2. Beril N.J. and Karpotata, G. 1972 Development (Mc Graw Hill Publications)
3. Carlson, B.M. 1998 Pattern's foundations of Embryology (Mc Graw Hill publications: New York), Delhi
4. Dobzhansky, Th., F. J. Ayala, G. L. Stebbins & J. M. Balentine, 1976. Evolution. Surjeet Publication,
5. Freeman, S and J. C. Herron 1998. Evolutionary Analysis. Prentice Hall, New Jersey.
6. Futuyma D. J. 1986. Evolutionary Biology. Sinauer Associates, INC. Sunderland.
7. Gilbert S.F. 1997 Developmental Biology Fifth edn. (Sinauer Associates Publications, Sunderland)
8. Gilbert, S.F. and Raunio, A.M. 1977 Embryology – Constructing the Embryo (Sinauer Associates Inc. Pub: Sunderland USA)
9. Grunz, H. 2004 Vertebrate Organizer – pp 429 (Springer)

10. Guilbert S.F. and Mussach. S. 1999 Developmental Biology (Sinquer Associates Publication,
11. Smith, J. M. 1998. Evolutionary Genetics. Oxford University Press. Oxford.
12. Stearns, S. C. and R. F. Hoekstra 2000. Evolution: An Introduction. OxfordUniversity Press, Oxford.
13. Strickberger, M. W. 1990. Evolution. Jones and Bartlett Publishers. Boston
14. Campbell, N.A. and Reece, J. B. (2008) Biology 8th edition, Pearson Benjamin Cummings, San Francisco.
15. Raven, P.H et al(2006) Biology 7th edition Tata McGrawHill Publications,New Delhi

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

Question Paper Pattern

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (5 questions)	30
TOTAL		60

PAPER CODE ZO 6P2

ZOOLOGY

SEMESTER-VI

PRACTICAL VIII

ZO 6P2: DEVELOPMENTAL AND EVOLUTIONARY BIOLOGY

Zoology Core Lab Course Content

Course Title: DEVELOPMENTAL AND EVOLUTIONARY BIOLOGY	Course Credits: 2
Course Code: ZO 6P2	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 4 Hours
Formative Assessment Marks: 25	Summative Assessment Marks: 25

Course Outcomes (COs):

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

- Describe the diversity of life, general rules of animal taxonomy, symmetry, germ layers, coelomic cavities, metamerism and cephalization.
- To identify and understand the larval forms of non-chordates.
- To outline the life cycle of parasites and their impacts on health.
- To identify the appendages of prawn and a thorough understanding of its body plan.

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	X	X	X	X	X	X	X	X	X	X
II Critical thinking	X	X	X	X	X	X	X	X	X	X	X
III Analytical reasoning	X	X	X	X	X	X	X	X	X	X	X
IV Research skills	X	X	X	X	X	X	X	X	X	X	X
V Team work	X	X	X	X	X	X	X	X	X	X	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

Total Number of Practicals	10 Units
Lab Course Content	
Developmental biology	
1. Culture techniques and observation of life stages of <i>Drosophila</i> (egg, larval instars, pupa & adult)	1 unit
2. Frog embryology: Study of cleavage, blastula, gastrula and neurula	1 unit
3. Chick embryology: Study of 18, 24, 36, and, 48 hours chick embryo	1 unit
4. Human embryology: T.S. of fallopian tube and Uterus (Proliferative and Secretory phase).	1 unit
5. Placenta: Morphological types: Cotyledonary type (sheep), Monodiscoidal type (human). Histological types: Haemochorial (Human).	1 unit
6. Model organisms: <i>Caenorhabditis elegans</i> , Zebrafish, Mouse, <i>Drosophila</i> .	1 unit
Evolutionary biology	
1. Study of anatomical evidence and modifications in evolution	3 units
a. <i>Homologous organs</i> (Forelimbs of Frog, Bird, and Bat). <i>Analogous organs</i> (Bird and Insect wing)	
b. <i>Vestigial organs:</i> Appendix, Coccyx, molar tooth, auricular muscles of ear pinna	
c. <i>Serial Homology:</i> Study of modifications in mounted prawn appendages.	
d. <i>Phylogenetic homology:</i> Mounting of mosquito and <i>Drosophila</i> mouth parts and wings.	
2. Paleontology:	
a. Fossil formation and types: Molds and Casts (Ammonites, bivalve), Connecting links: <i>Platypus</i> and <i>Peripatus</i> , Living fossil: <i>Nautilus</i>	1 unit

Pedagogy: Lectures, Presentations, videos, Virtual Labs, Assignments, Tests, Individual or group Field oriented Project Report on or visit to a research institute.

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	25
Practical Internal Assessment	25
Total	50