



**VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY**

**JNANASAGARA CAMPUS, BALLARI-583105**

**DEPARTMENT OF STUDIES IN ZOOLOGY**

**I SEMESTER M.Sc. (ZOOLOGY) SYLLABUS**

**Effective From**

**2024-25**



**VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY**  
**JNANASAGARA CAMPUS, BALLARI-583105**

**Department of Studies in Zoology**

**Programme:** Master of Science (M.Sc.) in Zoology

**Programme Overview:**

Duration: 2 Years (4 semesters) Programme Code: 901

Master of Science (M.Sc.) in Zoology aims to equip students with recent advances in Zoology from organismic to reductionist biology. It also aims to empower students to understand the challenges of society and the country that falls into the realms of Zoology, such as Aquaculture, Molecular cell biology, stem cell biology, Molecular endocrinology, developmental biology, Reproductive biology, Cancer Biology, Physiology, ethology, chronobiology, wild life conservation, toxicology, biodiversity etc. It also offers students to a series of elective courses so that they can choose to specialize in the specific area of their interests in Zoology.

**Programme Educational Objectives (PEOs):**

After 3-4 years of completion of the programme the graduates will be able to:

1. To provide basic knowledge of animal structure, function and behavior.
2. To provide practical skills and knowledge in the field of applied zoology, this can make a path for self employment opportunities in Aquaculture, Apiculture, Lac culture and Sericulture.
3. To enhance practical skill in current advances in Zoology.
4. To inculcate critical thinking and analytical skills to enable students to pursue higher studies and research in Life Sciences or related fields of Zoology.
5. Occupy positions in academic/research institutions / industry.
6. Demonstrate leadership qualities to achieve professional and organizational goals with commitment to ethical standards and team spirit.

**Programme Outcomes (POs):**

At the end of the programme the students will be able to:

1. The student would sufficiently be skilled and empowered to solve the problems in the realms of Zoology and its allied areas.
2. Understand the unity of life with the rich diversity of organisms and their ecological and evolutionary significance.
3. Opportunities of continuing education and professional development.
4. Acquire basic skills in the observation and study of nature, biological techniques, experimental skills and scientific investigation.
5. Demonstrate the ability to propose and execute a research project, and ethically report the results with concern for society and environment.
6. Enable the students to avail career opportunities in teaching, industry and research.
7. Work in a group to execute a project and contribute as an individual.
8. Use tools of information technology for all activities related to Zoology.
9. Develop lifelong learning habits by continuously updating advances in Zoology.



## VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY

Distribution of Courses/Papers in Postgraduate Programme I Semester as per Choice Based Credit System (CBCS) Proposed for

PG Program in Zoology

### M. Sc. I - SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
<b>FIRST</b>	DSC1	24ZOO1C1L	Systematics and Biology of Non-Chordates	30	70	100	4	-	-	4	3
	DSC2	24ZOO1C2L	Aquaculture and Fishery Biology	30	70	100	4	-	-	4	3
	DSC3	24ZOO1C3L	Molecular Cell Biology and Genetics	30	70	100	4	-	-	4	3
	DSC4	24ZOO1C4L	Stem Cell Biology and Regenerative Medicine	30	70	100	4	-	-	4	3
	SEC1	24ZOO1S1LP	Vermiculture and Vermitechnology	20	30	50	1	-	2	2	1
	DSC1P1	24ZOO1C1P	Systematics and Biology of Non-Chordates Lab	20	30	50	-	-	4	2	4
	DSC2P2	24ZOO1C2P	Aquaculture and Fishery Biology Lab	20	30	50	-	-	4	2	4
	DSC3P3	24ZOO1C3P	Molecular Cell Biology and Genetics Lab	20	30	50	-	-	4	2	4
<b>Total Marks for I Semester</b>						<b>600</b>				<b>24</b>	

## II-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
<b>SECOND</b>	DSC5	24ZOO2C5L	Biology of Chordates	30	70	100	4	-	-	4	3
	DSC6	24ZOO2C6L	Developmental Biology and Molecular Endocrinology	30	70	100	4	-	-	4	3
	DSC7	24ZOO2C7L	Ethology and Chronobiology	30	70	100	4	-	-	4	3
	DSC8	24ZOO2C8L	Cancer and Radiation Biology	30	70	100	4	-	-	4	3
	SEC2	24ZOO2S2LP	Non-clinical Safety Evaluation of Drugs (with MathWorks)	20	30	50	1	-	2	2	1
	DSC5P4	24ZOO2C5P	Biology of Chordates Lab	20	30	50	-	-	4	2	4
	DSC6P5	24ZOO2C6P	Developmental Biology and Molecular Endocrinology Lab	20	30	50	-	-	4	2	4
	DSC7P6	24ZOO2C7P	Ethology and Chronobiology Lab	20	30	50	-	-	4	2	4
<b>Total Marks for II Semester</b>						<b>600</b>				<b>24</b>	

### III-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
<b>THIRD</b>	DSC9	24ZOO3C9L	Reproductive Biology and Artificial Organs	30	70	100	4	-	-	4	3
	DSC10	24ZOO3C10L	Environmental Biology	30	70	100	4	-	-	4	3
	DSE1	24ZOO3E1AL	A) Human Physiology	30	70	100	4	-	-	4	3
		24ZOO3E1BL	B) Biophysics and Biostatistics								
		24ZOO3E1CL	C) Parasitology, Evolutionary Biology and Paleozoology								
	DSE2	24ZOO3E2AL	A) Immunology, Proteomics and Genomics	30	70	100	4	-	-	4	3
		24ZOO3E2BL	B) Biochemistry and Enzymology								
		24ZOO3E2CL	C) Neurobiology and Aging								
	GEC1	24ZOO3G1AL	A) Wild life conservation and management	20	30	50	2	-	-	2	1
		24ZOO3G1BL	B) Entrepreneurial Zoology								
		24ZOO3G1CL	C) Hormones and Diseases								
	SEC3	24ZOO3S3LP	Research Methodology	20	30	50	1	-	2	2	2
	DSC9P7	24ZOO3C9P	Reproductive Biology and Artificial Organs Lab	20	30	50	-	-	4	2	4
DSC10P8	24ZOO3C10P	Environmental Biology Lab	20	30	50	-	-	4	2	4	
<b>Total Marks for III Semester</b>						<b>600</b>				<b>24</b>	

### IV-SEMESTER

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
FOURTH	DSC11	24ZOO4C11L	Biodiversity and Conservation	30	70	100	4	-	-	4	3
	DSC12	24ZOO4C12L	Toxicology	30	70	100	4	-	-	4	3
	DSE3	24ZOO4E3AL	A) Agricultural Zoology and Entomology	30	70	100	4	-	-	4	3
		24ZOO4E3BL	B) Applied Zoology								
		24ZOO4E3CL	C) Animal Biotechnology								
	DSE4	24ZOO4E4AL	A) Genetic Engineering	30	70	100	4	-	-	4	3
		24ZOO4E4BL	B) Histology and Histotechniques								
		24ZOO4E4CL	C) Livestock Management and Animal Husbandry								
	GEC2	24ZOO4G2AL	A) Global Environmental Issues	20	30	50	2	-	-	2	2
		24ZOO4G2BL	B) Public Health, Hygiene and diseases								
24ZOO4G2CL		C) Human reproductive health issues and Sex Education									
DSC11L9	24ZOO4C11P	Biodiversity and Conservation Lab	20	30	50	-	-	4	2	4	
Project	24ZOO4C1R	Research Project	30	70	100		-	8	4	4	
<b>Total Marks for IV Semester</b>						<b>600</b>				<b>24</b>	

(I-IV semester)-

**Total Marks: 2400**

**Total credits: 96**

**DSC – Department Specific Core, DSE – Discipline Specific Elective, SEC – Skill Enhancement Course, GEC – Generic Elective Course, IA – Internal Assessment, SEE – Semester End Examination, L – Lecture, T – Tutorial, P – Practical.**

## M.Sc. Zoology First Semester

<b>Course:</b> Systematics and Biology of Non-Chordates	<b>Course code:</b> 24ZOO1C1L
<b>Teaching Hours/Week (L-T-P):</b> 4 - 0 - 0	<b>No. of Credits:</b> 04
<b>Internal Assessment:</b> 30 marks	<b>Semester End Examination:</b> 70 marks

**Course Objectives:** To understand the evidence that living species share descent from common ancestry and how this fact explain the traits of living species. Makes students to understand how life evolved from simple to complex organization by division of labour and enhancing efficiency in invertebrates.

### Unit 1

**16 Hours**

**Levels of Taxonomy:** Alpha, Beta & Gamma Taxonomy; Cytotaxonomy, Chemotaxonomy, Numerical taxonomy, Molecular taxonomy, Dendrogram, Cladistics.

Nominalistic Species Concept, Typological Species Concept, Phenetic Species Concept, Biological Species Concept, Evolutionary Species Concept, Ecological Species Concept, Recognition Species Concept, Aberrant Species Concept.

Monotypic and Polytypic Species, Allopatric and Sympatric Species, Peripatric and Parapatric Species, Cryptic Species and Sibling Species, Intraspecific Categories, Invasive species, Alien species, Indicator species, Keystone species, Umbrella species, Flagship species, Charismatic species.

General characters and classification of invertebrate phyla

From protozoa to Echinodermata (including minor phyla).

Phylogentic interrelationship between protochordates and chordates

### Unit 2

**12 Hours**

General characters and classification of Chordates

From Pisces to Mammals (including Protochordates)

Importance of Museum Collections, Methods for collecting non-chordates, Methods for Collecting Chordates, Preservation of non-chordates, Preservation of Chordates, Curation, Identification Method. Taxonomic keys- different types of Keys.

Zoological Nomenclature: Basic concept of ICZN, Binomial Nomenclature, Trinomial Nomenclature, Important rules, IUCN red list of threatened species.

### Unit 3

**12 Hours**

Locomotion in invertebrates

Ultrastructure of protozoan locomotory organs (pseudopodia-cytoplasmicorganells, flagella, cilia and pellicularmyonemes) and mechanism of various modes of locomotion;

Nutrition and Respiration

Filter feeding in Polychaeta, Mollusca and Echinodermata; Respiratory organs in Arthropoda; Mechanism of gaseous exchange in tracheal respiration in Insecta and gill respiration in Crustacea. Respiration in mollusca: Respiratory pigments, Excretion  
Mechanism of excretion (nitrogenous excretory products, transport of water and salts) in Polychaeta,

#### Unit 4

14 Hours

Reproduction

Structure and mechanism of reproduction in Dugesia, Fasciola, Taenia and Ascaris. Larval forms and their significance in Arthropoda and Echinodermata

Nervous System

Primitive nervous system: Coelenterata and Echinodermata, Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopod).

#### Reference Books:

1. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.
2. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
3. Ernst Mayer and Peter D. Ashlock: Principle Elements of Taxonomy.
4. G. G. Simpson. Principle of animal taxonomy; Oxford IBH Publishing Company.
5. Modern Text Book of Zoology: Invertebrates: R. L. Kotpal Rastogi Publications
6. Parker, T. S. and Haswell, W. A., Text Book of Zoology, Vol. II, ELBS, 1978.
7. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
8. V.C Kapoor-Theory and practice of animal taxonomy, 6TH EDITION 1983(Reprint 2011).

#### Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	General taxonomic rules on animal classification of chordates and evolutionary significance
2	Study Protochordata to Mammalia with taxonomic keys
3	To understand the animal diversity around us, principles of classification of animals and terminology needed in classification
4	Imparts conceptual knowledge of vertebrate adaptations in relation to their environment and Imparts conceptual knowledge of vertebrate adaptations in relation to their environment
5	Enhancement of research skills like critical thinking

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## M.Sc. Zoology First Semester

<b>Course:</b> Aquaculture and Fish Biology	<b>Course code:</b> 24ZOO1C2L
<b>Teaching Hours/Week (L-T-P):</b> 4 - 0 - 0	<b>No. of Credits:</b> 04
<b>Internal Assessment:</b> 30 marks	<b>Semester End Examination:</b> 70 marks

### Course Objectives:

This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish, and prawn. The course will include an opportunity to conduct hands-on activities related to culture and husbandry of animals.

### Unit 1

**14 Hours**

Historical background and present status of aquaculture: purpose and importance of aquaculture.  
Types of culture systems: Traditional, extensive, semi-intensive, intensive, super-intensive.  
Types of aquaculture: Freshwater aquaculture, brackish water aquaculture and mariculture,  
Merits and demerits,  
Characteristic features of cultivable species (Indian major carps, murels, catfish and tilapia).  
Selection criteria of cultivable species.

### Unit 2

**14 Hours**

Design, construction and management of ponds, types of ponds.  
Control of aquatic weeds and predators.  
Composite fish culture: Mono sex culture, culture of air-breathing fishes, sewage fed fish culture  
Fish-cum duck culture: induced breeding of carps: Brood stock management.  
Culture of aquarium fishes: breeding of aquarium fishes, Home aquarium and its set up.

### Unit 3

**14 Hours**

Fish breeding: Synthetic hormones for induced breeding – GnRH analogue structure and function  
Selective breeding for improving fish stocks - hybridization in Indian fishes. Gynogenesis, Androgenesis, triploidy, tetraploidy, hybridization, sex reversal and breeding, Production of transgenic fish,  
Impact of GMOs on aquatic biodiversity  
Impact of Aquaculture on Environment  
Methods of Fishing: Crafts and gear technology  
Fish preservation and processing technology

### Unit 4

**14 Hours**

Nutrition in Aquaculture: Nutrient and non-nutrient diet components,  
Preparation and processing of feed, feed formulae,  
Natural and supplementary feed and their utilization  
Fish diseases: Parasitic, protozoan, bacterial, fungal and viral diseases and their control measures.

Inland fisheries: Freshwater, riverine, reservoir, pond and cold-water fisheries.

Estuarine and brackish water and Marine fisheries and their economics.

**Reference Books:**

1. R. Santhanam, N. Sukumaran and Natarajan, - A manual of fresh water aquaculture, Oxford and IBH Publishing Co Pvt. Ltd., Mumbai.
2. B.N. Yadav, - Fish and fisheries, Daya Publishing House, Delhi.
3. Mathew Landan, 1991. Introduction to aquaculture, John Wilay and Sons Inc..
4. V.R.P. Sinha, 1993. Acompendium of aquaculture Technologies for developing countries, Oxford and IBH Publishing Company PVT. Ltd.
5. V.G. Jhingran, 1991. Fish and fisheries of India, Hindustan Publishing Corporation, Delhi.
6. T.V.R. Pillay – Aquaculture principles and practives, Fishing new Books, Blackwell Science Ltd., Oxford.
7. Shanmugam, K. 1990. Fishery Biology and Aquaculture, Hindustan Pub. Corporation, New Delhi.
8. C.V. Kurian and Sebastein – Prawn and Prawn fisheries of India, Hindustan Publishing House, New Delhi.
9. Elvire Balugal, A. 1984. Aquaculture systems and practices – A selected Review, Daya Publishing House, New Delhi.
10. B.N.Yadav, 1995. Fish Endocrinology, Daya Publishing House, New Delhi.
11. Handbook of Fisheries and Aquaculture. 2013. Indian Council of Agricultural Research, ICAR, DIPA, New Delhi, India.

**Course Outcomes (CO): After completion of this course student should able to**

<b>CO</b>	<b>Statement</b>
1	Understanding of design and construction of Fish hatchery and Shrimp hatchery. Feasibility of using sewage water for aquaculture.
2	Gain the knowledge of advance biological techniques used for improvement of fish culture and research.
3	Understand the culture techniques of various aquatic organisms helps in the production of healthy food for human consumption in a sustainable manner and also in employment generation.
4	Students can start their own business i.e., self employments.
5	Understand Criteria for the selection of species for culture and concepts of different types of culture.

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## M.Sc. Zoology First Semester

<b>Course:</b> Molecular Cell Biology and Genetics	<b>Course code:</b> 24ZOO1C2L
<b>Teaching Hours/Week (L-T-P):</b> 4 - 0 - 0	<b>No. of Credits:</b> 04
<b>Internal Assessment:</b> 30 marks	<b>Semester End Examination:</b> 70 marks

**Course Objectives:** This course will provide knowledge about the complex organization in the eukaryotic cell and the molecular mechanisms of the cellular processes that exist in all cell types.

### Unit 1

**14 Hours**

Scope of molecular biology, Synthetic Biology, Cell theory, Cellular organization, Central dogma of molecular biology. Evidences for DNA as a genetic material. Biochemistry of cell: Properties of water, Carbohydrate classification, Protein structures and bond formation, Lipids and Nucleic acids: Types of DNA and RNA, Biological significance of biomolecules. Structure of eukaryotic chromosome; Chromosomal condensation during mitosis; Structure of dsDNA, ssRNA, dsRNA, Replication of DNA, DNA damage and repair mechanisms.

### Unit 2

**16 Hours**

Genome organization: Structure of gene, Prokaryotic and eukaryotic transcription; post-transcriptional processing; Reverse transcription. Genetic code, Gene translation and regulation. DNA sequencing, Genetic engineering technology. Molecular organisation and functions of cell organelles. Cell cycle: Phases of cell cycle, molecular events during different stages of cell cycle, Cyclins and Cyclin-Dependent Kinases, regulation of CDK-Cyclin activity, Senescence, Apoptosis. Cell junctions; Signal transduction; Transport across cell membranes.

### Unit 3

**12 Hours**

Molecular biology in human perspective: Cell replacement therapy, Free radicals and aging, protein misfolding, Problem of antibiotic resistance, defects in ion-channels and transporters, diseases resulting from abnormal lysosomal, mitochondrial and peroxisomal function, cilia in development of disease. Application of genomics in medicine and experimental pathways and longevity. Autoimmune disorders and disorders associated with G-protein coupled receptors. RNA interference and clinical application.

### Unit 4

**14 Hours**

Elements of heredity and variation; Mendelian inheritance and extensions to Mendelian inheritance in brief. Sex-linked; Sex-influenced and Sex-limited inheritance. Cytoplasmic inheritance. Multiple allelism: blood group inheritance pattern, Rh incompatibility. Eukaryotic model systems for genetic analysis: life cycle and importance of Drosophila and Zebra fish. Genetic basis of human diseases: Numerical and structural anomalies of chromosomes. Inherited biochemical diseases: Lipid metabolism disorder, Carbohydrate associated disorder, Defects in purine metabolism.

### Reference Books:

1. A.G. Motulsky and F. Vogel (1986) Human Genetics
2. Alberts, B., Bray Dennis, Lewis Julian, Raff Martin, Roberts. K and Watson, J.D. Molecular Biology of the Cell. Garland Publishing Inc. New York, 1994.
3. Bray, B. A. D, Lewis J, Raff M, Roberts K and Watson J.D (1995) Molecular biology of the cell, II edition, Garland Publishing Company Ltd. New York and London.

4. Brown, T. A. (1998) Genetics a molecular approach, 3rd edition, Chapman & Hall Publishers, London.
5. Burns, G. W. (1983) The science of genetics, V edition, McMillan Pub. Co., Inc., New York.
6. Connor, J. M. and Smith M. A. F. (1987) Essential Medical Genetics, 2nd edition, Black well scientific publications.
7. Cummings, M.R. (2009). Human Heredity: Principles and Issues. Pacific Grove, CA:Brooks/Cole.
8. Curt Stern (1960) Principles of Human Genetics 5. Robert et al., (2015)Thompson and Thompson Genetics in Medicine, Elsevier, Saunders, London
9. De Robertis, E. D. P, De Robertis E. M.F (1995) Cell and Molecular Biology, VIII edition, Indian edition
10. Fraser, C. F. and Nora J. J. (1986) Genetics of man, 2nd edition, Lea and Febiger publishers, Philadelphia.
11. Gardner, E. J., Simmins M. J. and Snusstad D. P. (1991) Principles of Genetics, 8th edition, John Wiley and Sons Inc.
12. Hartl, D. L. (2001) Genetics: Analysis of genes and genomes, 4th edition, Jones & Bartlett publishers, Boston.
13. Hassard, T.H. (1991) Understanding Biostatistics, Mosby year Book St. Louis.
14. Hutt, F. B. and Rasmusen B. A. (1982) Animal genetics, 2nd edition, John Wiley & sons, New York.
15. Gerald Karp (2013) Cell and molecular biology, concepts and experiments, 7<sup>th</sup> Ed. Wiley.
16. Lewis, R. (2008) Human Genetics: Concepts and Applications, McGraw-Hill Publishing, New York, 8th ed
17. R. F. Mueller and I.D Yound (2001) Emery's Elements of Medical Genetics
18. Robert F. Weaver (2012) Molecular Biology fifth edition, McGraw Hill companies Inc.
19. Stickberger, N.W. Genetics. MacMillan Publishing Co. New York, 1985.
20. Watson, J.D et al., Recombinant DNA. W.H.Freeman & Co, 1992.

**Course Outcomes (CO): After completion of this course student should able to**

<b>CO</b>	<b>Statement</b>
1	Understand how the cell functions as a unit of life
2	Gain knowledge about the techniques and experiments that contributed to the understanding of molecular mechanisms of the cellular processes
3	Formulate the tools and techniques used in rDNA technology
4	Solve Mendelian monohybrid, dihybrid experiment related problems and carry out blood grouping and derive to the conclusion of Rh compatibility
5	Write sources and cause of genetic disorders in human beings and Identify and name the genes responsible for anomalies in human chromosomes

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## M.Sc. Zoology First Semester

<b>Course:</b> Stem Cell Biology and Regenerative Medicine	<b>Course code:</b> 24ZOO1C4L
<b>L-T-P per week:</b> 4-0-0	<b>No. of Credits:</b> 04
<b>Internal Assessment:</b> 30 marks	<b>Semester End Examination:</b> 70 marks

**Course Objectives:** The objective of this paper is to familiarize the students with stem cell technology and its applications for betterment of the society. The course is designed to give a broad view of mammalian stem cells, reviewing where they are found in the body, the different types and how they are cultured. The topics will cover the basic biology of these stem cells as well as bioengineering and application of these stem cells to potential treatments of human diseases.

<b>Unit 1</b>	<b>15 hours</b>
<p>Overview of stem cells: Definition and criteria for stem cells;  Types of stem cells; Stem cell markers; Stem cell niches.  Growth Factors and Paracrine mechanism and action of stem cells.  Molecular concepts of stem cells: Molecular Basis of Pluripotency; Mechanisms of self renewal; Cell cycle regulators in Stem cells; Somatic cell nuclear transfer technology  Aging and stem cell renewal  Cancer stem cells: Stem cell origin of cancer, Cancer stem cells, Pathways involved in stem cells.</p>	
<b>Unit 2</b>	<b>13 hours</b>
<p>Embryonic and adult stem cells: Embryonic stem cells: Isolation, properties, test for pluripotency, and differentiation.  Embryonic carcinoma cells: Teratomas and Teratocarcinoma.  Adult stem cells: Different types of adult stem cells based on source (cord blood, bone marrow, adipose, endometrium etc) and lineages (hematopoietic stem cells, mesenchymal stem cells side population, endothelial progenitor cells)</p>	
<b>Unit 3</b>	<b>14 hours</b>
<p><b>Stem cell therapy:</b> Autologous and allogenic stem cell transplantation, HLA typing  Gene therapy using stem cells: Methods of gene therapy.  Applications of stem cells in gene therapy.  Tissue derivation from different germ layers  Significance of pluripotency  Induced pluripotency of stem cells.  Recent advances, applications and challenges in the production of pluripotent stem cells.</p>	
<b>Unit 4</b>	<b>14 Hours</b>
<p><b>Stem cells and regenerative medicine:</b> Neural stem cells in neurodegenerative diseases;  Hematopoietic stem cell transplantation  Epithelial stem cells and burns  Stem cells and heart disease</p>	

Pancreatic stem cells and diabetes  
 Liver stem cells and cell therapy for liver disease  
 Embryonic stem cells in tissue engineering, stem cell banking,  
 Ethical concerns in stem cell research.

**Reference Books:**

1. Stem cell biology and Gene therapy, Peter J QuesenBerryr, Willey – Less.
2. Essentials of Stem Cell Biology by Robert Lanza and Anthony Atala, Elsevier
3. Stem Cells: From Basic Research to Therapy, Volume 1: Basic Stem Cell Biology, Tissue Formation during Development, and Model Organisms by Federico Calegari, Claudia Waskow, Taylor and Francis group.
4. Essentials of Stem Cell Biology, Third Edition – Edited by Robert Lanza and Anthony Atala. Academic Press, CA, USA (2013).
5. Stem Cell Biology - Edited by Daniel R Marshak, Richard L. Gardner and David Gottlieb. Cold Spring Harbor Press, NY, USA (2001).
6. “Hand book of Stem Cells” Edited by RoberLanza, Elsevier, Academic Press, 2011.
7. “Stem Cells Handbook”, Edited by Stewart Sell, Human Press, 2010.

**Course Outcomes (CO): After completion of this course student should able to**

CO	Statement
1	Learn the various types of stem cells their identification and isolation.
2	Understand the concept of stem cell niche and its importance.
3	Learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells.
4	Learn stem cell cycle regulation and explore various animal models used in stem cell research.
5	Understand about stem cell cycle regulation
6	Describe the applications of stem cells in diseases, injury and gene therapy

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## M.Sc. Zoology First Semester

<b>Course:</b> Vermiculture and Vermitechnology	<b>Course code:</b> 24ZOO1S1LP
<b>L-T-P per week:</b> 1-0-2	<b>No. of Credits:</b> 02
<b>Internal Assessment:</b> 15 marks	<b>Semester End Examination:</b> 35 marks

### Course Objectives:

1. To make wealth out of waste.
2. To assist the students in Vermitechnology for sustainable agriculture practices.
3. To develop the concept of scientific organic natural farming with a key component of making organic manure through earthworms.
4. To provide the knowledge of how to turn all kinds of waste garbage to a valuable compost.
5. To impart the knowledge of converting the weeds into food of earthworms and preparing vermicompost.
6. To provide the knowledge of commercial vermicomposting, including rearing of earthworms and production of earthworm cast.

### Unit 1

**7 hours**

Introduction to vermiculture

Definition, scope of vermiculture, types of earthworms

Ecological grouping – Epigeic, Anecic and Endogeic species

Ecological role and economic importance of earthworms.

Role as four R's of recycling reduces, reuse, recycle, restore.

Role of earthworms In waste management

Vermifilter, Earthworm as farmer's friend, earthworms as bioreactors, organic farming

### Unit 2

**7 hours**

Vermiculture techniques and applications of Vermicompost

Advantages of vermiculture,

Vermicomposting technology,

Methods of vermicomposting,

Large scale manufacture of vermicompost, worm casts, vermicompost, vermivash, Role of earthworms in soil fertility, use of vermicompost for crop production, use of vermicompost in land improvement and reclamation.

Vermicompost application on soil and plant growth,

Vermicompost as a organic manure a good substitute of fertilizers.

Marketing of vermicomposting products and financial support by governments and NGOs for vermiculture.

### Unit 3

**28 hours**

## Labs to be conducted

1. Key to identify different types of earthworms
2. Field trip- Collection of native earthworms & their identification
3. Study of Sytematic position, habits, habitat & External characters of Eisenia fetida/ Eudrilus eugeniae
4. Study of cocoon and vermicast
5. Study of Life stages & development of Eisenia fetida/ Eudrilus eugeniae
6. Study of Vermiculture, Vermiwash & Vermicompost equipments, devices
7. Preparation of vermibeds, maintenance of vermicompost & climatic conditions.
8. Establishment of vermicomposting unit Bed method/pit method
9. Establishment of vermiwash unit
10. Harvesting, packaging, transport and storage of Vermicompost and separation of life stages
11. Study of Pests and diseases of Earthworms
12. Study the effects of vermicompost & vermiwash on any two short duration cropplants
13. Budget and cost scenario of vermiculture (project)

### Reference Books:

1. Bhatt J.V. & S.R. Khambata (1959) "Role of Earthworms in Agriculture" Indian Council of Agricultural Research, New Delhi
2. Dash, M.C., B.K.Senapati, P.C. Mishra (1980) "Verms and Vermicomposting" Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5-8, 1984, (Part B), School of Life Sciences, Sambalpur University, JyotiVihar, Orissa.
3. Edwards, C.A. and J.R. Lofty (1977) "Biology of Earthworms" Chapman and Hall Ltd., London.
4. Lee, K.E. (1985) "Earthworms: Their ecology and Relationship with Soils and Land Use" Academic Press, Sydney.
5. Kevin, A and K.E.Lee (1989) " Earthworm for Gardeners and Fisherman" (CSIRO, Australia, Division of Soils)
6. Rahudakar V.B. (2004). GandulkhatashivayNaisargeekParyay, Atul Book Agency, Pune.
7. Satchel, J.E. (1983) "Earthworm Ecology" Chapman Hall, London.
8. Wallwork, J.A. (1983) "Earthworm Biology" Edward Arnold (Publishers) Ltd. London.

### Course Outcomes (CO): After completion of this course student should able to

CO	Statement
1	Learn the various types of stem cells their identification and isolation.
2	Understand the concept of stem cell niche and its importance.
3	Learn about cancer stem cells and study the various cell signalling pathways up regulated in cancer stem cells.
4	Learn stem cell cycle regulation and explore various animal models used in stem cell research.
5	Understand about stem cell cycle regulation
6	Describe the applications of stem cells in diseases, injury and gene therapy

## M.Sc. Zoology First Semester

<b>Course:</b> Lab on Systematics and Biology of Non-Chordates	<b>Course code:</b> 24ZOO1C1P
<b>L-T-P per week:</b> 0-0-4	<b>No. of Credits:</b> 02
<b>Internal Assessment:</b> 20 marks	<b>Semester End Examination:</b> 30 marks

### Course Objectives:

1. To observe various non chordate specimens by using Microscope
2. To know the various systems (Digestive system, circulatory system and Reproductive system) of rat by using virtual laboratory
3. To inculcate the significance of various chordates/ non chordates.

### List of Experiments

1. **Study of Available Museum Specimens of Non-Chordate animals**
  - a. **Protozoa:** Amoeba, Noctiluca, Monocystis, Trypanosoma, Leishmania.
  - b. **Porifera:** Leucosolenia, Grantia, Scypha, Hyalonema, Euplectella.
2. **Identification and classification of Invertebrate animals**
  - a. **Coelentrata:** Porpita, Vellela, Pennatula, Alcyonium, Adamsia.
  - b. **Platyhelminthes:** Dugesia, Fasciola and Taenia. Mature and gravid proglottids of Taenia.
  - c. **Nematoda:** Dracunculus, Wuchereria, Trichinella, Schistosoma and Enterobius.
  - d. **Annelida:** Aphrodite, Arenicola, Pheretima, Pontobdella, and Hirudinaria.
3. **Identification and classification of Invertebrate animals**
  - a. **Arthropoda :** Limulus, Spider, Palamnaeus, Apus, Lepas, Sacculina, Odontotermes, Bombyx, Xenopsylla, Apis, Julus
  - b. **Mollusca:** Chiton, Dentalium, Pila, Turbinella, Aplysia, Mytilus, Octopus.
  - c. **Echinodermata:** Pentaceros, Asterias, Ophiothrix, Echinus, Holothuria
4. **Study of the following Chordates through Specimens/Charts/ Models**
  - a. **Protochordata:** Herdmania, Amphioxus, Amphioxus
  - b. **Cyclostomata:** Petromyzon and Myxine.
  - c. **Pisces:** Torpedo, Hippocoampus, Echeineis, Clarius, Channa, Anguilla.
5. **Identification and classification of vertebrate animals**
  - b. **Amphibia:** Ichthyophis, Amblystoma, Axolotl larva, Hyla, Siren, Rhacophorus.
  - c. **Reptilia:** Draco, Chamaeleon, Uromastix, Testudo, Trionyx, Russels viper, Hydrophis, Crocodile, Gavialis.
  - d. **Aves:** Psittacula, Eudynamis, Bubo, Alcedo, Ostrich, Kiwi, Kite, and Duck
  - e. **Mammalia:** Ornithorhynchus, Pteropus, Funambulus, Echidna, Kangaroo, Shrew, Loris, Seal/ Walrus, Dolphin, Sea Cow, Giant panda, Tapir,
6. Study of Morphometric measurements in fishes.
7. Study of external characters of Earthworm. Dissection of digestive and nervous system of Earthworm, Mounting of Setae, Nephridia & ovary of earth worm.

8. Dissection of digestive system and nervous system of Palaemon, Mounting of appendages of Palaemon
9. Dissection of digestive system and nervous system nervous system of cockroach. Mounting of salivary glands in cockroach.
10. **Study of larval forms:** Miracidium, Redia, Cercaria, Metacercaria, Trochophore, Nauplius, Bipinnaria, Ophiopluteus, Pluteus, Echinopluteus, Brachiolaria, Zoye, Mysis,
11. Examination of pond water collected/cultured from different places for identification of invertebrates.
12. Visit to any one National Park or Sanctuary OR Reserve forest area OR Skill based Educational programme/Lecture OR visit local education centres for specimen collection and preservation.

**Note:**

1. Experiments may be added/ modified as and when required with the approval of BoS.
2. Demonstration practical/ Dissection/Virtual dissection/Models/Chart of animal systems as per UGC guidelines.

**References:**

1. A Text Book of Zoology; T.J.Parkar and W.A.Haswell, McMillan.
2. Analysis of Vertebrate Structure: Milton Hildebrand, Wiley International
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
4. Biology of Invertebrates; J.A.Pechenik, 4th Ed, Tata McGraw Hill Publication.
5. Functional Anatomy of Vertebrates. An evolutionary perspective. K.F.Liem, W.E.Bemis, W, F.Walker, L.Grande, 3rd Ed. Harcourt College Publishers.
6. Invertebrate Zoology: Bares, R.D., Saunders Publication.
7. Life of Invertebrates; Russell, W.D. Hunter, McMillan
8. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
9. The Life of Vertebrates: J.Z.Young, ELBS-Oxford Univ. Press.
10. Vertebrate comparative anatomy, Function, Evolution, K.V. Kardong, 3rd Ed. Tata McGraw, Hill Publication.

**Course Outcomes (CO): After completion of this course student should able to**

CO	Statement
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
5	Enhancement of basic laboratory skill like keen observation and drawing

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## M.Sc. Zoology First Semester

<b>Course:</b> Lab on Aquaculture and Fish Biology	<b>Course code:</b> 24ZOO1C2P
<b>L-T-P per week:</b> 0-0-4	<b>No. of Credits:</b> 02
<b>Internal Assessment:</b> 20 marks	<b>Semester End Examination:</b> 30 marks

**Course Objectives:** This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, plankton analysis, spawning, larval culture and culture methodologies.

### List of Experiments

1. Identification of important cultivable species of fin fish and shell fish.
2. Common unwanted (weed and predatory) fishes in culture ponds – identification and their impact in aquaculture.
3. Collection, preservation and identification of common phytoplanktonic organisms in ponds.
4. Collection, preservation and identification of common zooplanktonic organisms in ponds – Rotifers, Cladocerans and Copepods.
5. Identification of aquatic insects in ponds.
6. Common floating, emergent and submerged aquatic vegetation in ponds..
7. Qualitative identification and estimation of ammonia and urea.
8. Estimation of tissue somatic index.
9. Determination of temperature, pH, salinity in the pond water sample.
10. Estimation of total alkalinity and total hardness.
11. Estimation of dissolved oxygen and free carbondioxide.
12. Estimation of phosphates and nitrites.
13. Estimation of COD and BOD.

### **Note:**

1. Experiments may be added/modified as and when required.

### **Reference Books:**

1. Bard. J (1986). Handbook of Tropical Aquaculture.
2. Santhanam, R. A. Manual of Aquaculture.
3. Fresh Water Fish Culture and Training, Neha Charan, Random Publications, 2012

### **Course Outcomes (CO): After completion of this course student should able to**

<b>CO</b>	<b>Statement</b>
1	Study the breeding, rearing, and harvesting of aquatic animals.
2	Know the methodology for the construction of hatcheries and farms.
3	Study the recent techniques and application for the practical aquaculture
4	Know culture practice and economic importance aquaculture
5	Understand the environmental impacts of aquaculture and Learn the importance of aquaculture

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## Zoology First Semester

<b>Course:</b> Lab on Molecular Cell Biology and Genetics	<b>Course code:</b> 24ZOO1C3P
<b>L-T-P per week:</b> 0-0-4	<b>No. of Credits:</b> 02
<b>Internal Assessment:</b> 20 marks	<b>Semester End Examination:</b> 30 marks

**Course Objectives:** This lab course will provide skills and firsthand practical knowledge about the biological molecules, biochemistry, chromosomal aberrations and tools and techniques in cellular mechanisms.

### List of Experiments

1. Study of microscopes: compound, dark-field, phase contrast, fluorescent, TEM and SEM.
2. Temporal mitosis in onion roots.
3. Meiosis in maize/ onion bud/grasshopper testes.
4. Isolation of genomic DNA from plant / animal tissue
5. Casein extraction from milk.
6. Decoding the genetic codes using base sequences.
7. Anomalies in chromosomes.
8. Micrometry: calibration of microscope and measurement of cell diameters.
9. Carbohydrate, protein and lipid tests
10. Barr body identification using buccal smear
11. Demonstration of agarose gel electrophoresis
12. Study of life cycle of drosophila, zebra fish and maintenance of stock
13. Problems based on mendelian laws, sex linkage
14. Centrifugation technique, colorimetry, chromatography and spectrophotometry
15. Blood grouping and Rh compatibility

#### **Note:**

1. Experiments may be added/modified as and when required with the approval of BoS.

#### **Reference Books:**

1. Bray, B. A. D, Lewis J, Raff M, Roberts K and Watson J.D (1995) Molecular biology of the cell, II edition, Garland Publishing Company Ltd. New York and London.
2. Brown, T. A. (1998) Genetics a molecular approach, 3rd edition, Chapman & Hall Publishers, London.
3. Connor, J. M. and Smith M. A. F. (1987) Essential Medical Genetics, 2nd edition, Black well scientific publications.
4. De Robertis, E. D. P, De Robertis E. M.F (1995) Cell and Molecular Biology, VIII edition, Indian edition
5. Fraser, C. F. and Nora J. J. (1986) Genetics of man, 2nd edition, Lea and Febiger publishers, Philadelphia.

6. Gardner, E. J., Simmins M. J. and Snusstad D. P. (1991) Principles of Genetics, 8th edition, John Wiley and Sons Inc.
7. Hartl, D. L. (2001) Genetics: Analysis of genes and genomes, 4th edition, Jones & Bartlett publishers, Boston.
8. Lewis, R. (2008) Human Genetics: Concepts and Applications, McGraw-Hill Publishing, New York, 8th ed
9. Robert F. Weaver (2012) Molecular Biology fifth edition, McGraw Hill companies Inc.
10. Watson, J.D et al., Recombinant DNA. W.H.Freeman & Co, 1992.

**Course Outcomes (CO): After completion of this course student should able to**

<b>CO</b>	<b>Statement</b>
1	To use the different types of microscopes
2	Identify The chromosomal aberrations by preparing karyotypes
3	Develop the skills to identify Molecular Structure of biomolecules
4	Carry out blood grouping and derive to the conclusion of Rh compatibility
5	Enhancement of basic laboratory skill like keen observation and drawing



**CBCS Question Paper Pattern for M.Sc. Zoology Semester End Examination with Effect from the AY 2024-25**

**Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)**

**Paper Code:**

**Time: 3 Hours**

**Note: Answer any *FIVE* of the following, each question carries equal marks Question No.1 is Compulsory.**

**Paper Title:**

**Max. Marks: 70**

Q1.	A	7 Marks
	B	7 Marks
Q2.		14 Marks
Q3.		14 Marks
Q4.		14 Marks
Q5.		14 Marks
Q6		14 Marks
Q7		14 Marks
Q8	A	7 Marks
	B	7 Marks

**Note: Questions No.1 to 8, shall be covered from each units with equal/proportionate weightage**

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**Skill Enhancement Courses (SECs)**

**Paper Code:**

**Time: 1 Hours**

**Paper Title:**

**Max. Marks: 30**

**There shall be Theory examination of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.**

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**VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY**  
JNANASAGARA CAMPUS, BALLARI-583105

**Department of Studies in Zoology**

**SYLLABUS**

Master of Science  
(II Semester)

With effect from:  
2024-25

**Distribution of Courses/Papers in Postgraduate Programme I to IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Program in Zoology**

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	Sem. Exam	Total	L	T	P		
<b>SECOND</b>	DSC5	24ZOO2C5L	Biology of Chordates	30	70	100	4	-	-	4	3
	DSC6	24ZOO2C6L	Developmental Biology and Molecular Endocrinology	30	70	100	4	-	-	4	3
	DSC7	24ZOO2C7L	Ethology and Chronobiology	30	70	100	4	-	-	4	3
	DSC8	24ZOO2C8L	Cancer and Radiation Biology	30	70	100	4	-	-	4	3
	SEC2	24ZOO2S2LP	Non-clinical Safety Evaluation of Drugs	20	30	50	1	-	2	2	1.5
	DSC5P	24ZOO2C5P	Biology of Chordates Lab	20	30	50	-	-	4	2	4
	DSC6P	24ZOO2C6P	Developmental Biology and Molecular Endocrinology Lab	20	30	50	-	-	4	2	4
	DSC7P	24ZOO2C7P	Ethology and Chronobiology Lab	20	30	50	-	-	4	2	4
<b>Total Marks for II Semester</b>						<b>600</b>				<b>24</b>	

**Department Name: Zoology**  
**Semester-II**

**DSC5: Biology of Chordates**

<b>Course Title:</b> Biology of Chordates	<b>Course code:</b> 24ZOO2C5L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):**

**At the end of the course, students will be able to:**

1. Impart teaching on chordates.
2. Draw a conclusion towards anatomical differences among vertebrates.
3. Design the tools for fishing and help in identifying the fishes.
4. Trace the migratory birds by morphological features.
5. Develop the aesthetic sense in protecting animal organisms.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<b>General characters of Chordata.</b> Theories of origin of chordates, Protochordata: Outline classification; General characters of Hemichordata, Urochordata and Cephalochordata. Life cycle of Salpa, Doliolum and Branchiostoma. Retrogressive metamorphosis. Origin, evolution and general characters of Agnatha (Ostracoderms and Cyclostomes) and Gnathostomata (Placoderms).	14
2	<b>Pisces:</b> Chondrichthyes and Osteichthyes, deep-sea adaptations, adaptive radiation in bony fishes, migration in fish, sensory, hydrostatic and lateral line system. <i>Amphibia:</i> Origin and evolution, adaptations in amphibia, neoteny, breeding behaviour and parental care.	14
3	<b>Reptiles:</b> Origin, adaptive radiation and evolution. Extinct reptiles, venomous and non-venomous snakes in India. Snake venom, snake bite, associated bones and muscles, snake bite treatment. <i>Aves:</i> Origin of birds and evidences, aerial adaptations and mechanism of flight, courtship and breeding behaviour, avian migration.	14
4	<b>Mammals:</b> Origin and evolution of mammals, Prototheria, Metatheria and Eutheria, and aquatic mammals. Structure of cutaneous, branchial and pulmonary respiration. <i>Integuments</i> of tetrapod and epidermal derivatives: glands, scales, horns, nails, hoofs, feathers, and hairs.	14
<b>References:</b>		

1. Barrington, E.J.W. (1965): The biology of Hemichordata and Protochordata. Oliver and Boyd, Edinburgh, UK.
2. Colbert, E.H. (2011) Evolution of the Vertebrates. 5th Edn. John Wiley and Sons Inc., New York
3. Hobart M. Smith, (1960). Evolution of Chordate Structure, Holt, Rinehart & Winston Inc. New York
4. Holstead. (1969) The Pattern of Vertebrate Evolution. Freeman and Co. San Francisco. U.S.A.
5. Hyman, L.H. (1966): Comparative Vertebrate Anatomy. The University of Chicago Press, Chicago
6. Jolie, M. (1968). Chordate Morphology. East West Press. Pvt, Ltd
7. Milton Hildebrand and George Goslow (2002): Analysis of Vertebrate Structure, 5th Edn. John Wiley and Sons Inc., New York
8. Romer, A.S. and Parson, T.S. (1978), Vertebrate Body. W.B. Saunders Co. Philadelphia.
9. Walter, H.E. and Sayles, L.D. Biology of vertebrates, MacMillan & Co. New York.
10. Waterman. A.J. 1971. Chordate Structure and Function. McMillan Co. London.
11. Weichert, C.K., Anatomy of Chordates McGraw Hill Book Co. Inc. London.
12. Young, J.Z. (1981): The Life of Vertebrates, 3rd Edn. Clarendon Press Oxford.

**DSC6: Developmental Biology and Molecular Endocrinology**

<b>Course Title:</b> Developmental Biology and Molecular Endocrinology	<b>Course code:</b> 24ZOO2C6L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Understand the patterns and process of embryonic development, body plan, fate map, induction, competence, regulative and mosaic development.
2. Understand molecular and genetic approach for the study of developing embryo which is not necessarily shared with any other disciplines in the biological sciences.
3. Understand relationship of central nervous system with peripehral endocrine system and controlled functions system in higher vertebrates.
4. Describe major signalling pathways in target cells for each hormone including feedback relationships.
5. Identify the organs involved in the endocrine function and an understanding of appropriate key human endocrine disorder will also be developed.
6. Understand the current developments in design and production of hormonal contraceptives.
7. Understand the mechanisms involved in production of recombinant protein hormones and their application in regulation of fertility in farm animals and humans.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<b>Early development and morphogentic movements.</b> Questions of Developmental Biology.Fertilization - Structure of the gametes- sperm and egg; recognition of sperm, egg and spermattraction; acrosome reaction,Species-specific recognition, gamete fusion and prevention of polyspermy; fusion of genetic material, activation of egg metabolism. Types of cleavage, blastula and gastrula of fruit fly. Morphogentic movements-Epiboly, Emboly, Invagination, Ingression, Delamination.	14
2	<b>Development and Endocrine glands:</b> Origin of anterior & posterior polarity, maternal effects of genes; Segmentation genes, homeotic selector genes. Generation of Dorso-ventral polarity.Axis formation in Amphibians: The progressive determination of amphibian axis, primary embryonic induction. Function of organizer Diffusible proteins of organizer.Structure and functions of endocrine glands. Endocrine, Paracrine and autocrine secretions, Local hormones, Neuroendocrine secretions and Neurotransmitters.	14
3	<b>Hormone action:</b> General classes of chemical messengers-Peptide, Amino acid derived and Steroid hormones, Eicosanoids and Pheromones.Glucose, Calcium and Sodium Homeostasis, Neuro-endocrine integration: milk ejection reflex. Signal transduction: secondary messengers - cyclic AMP, prostaglandins, DAG and calmodulin.Physiological actions of melatonin.	14

	Secretion and metabolism of thyroid hormones and Parathormone, Patho-physiology-Goiter, Grave's disease and Cretinism.	
4	<b>Hypothalamo-Hypophysial system.</b> Pituitary- Location, structure and functional cell types, Hypothalamo-hypophysial portal system, Pituitary hormone and their physiological actions. Pituitary patho-physiology: Hyperprolactinaemia, Pituitary dwarfism, Gigantism and Acromegaly. Anatomy, and histology of adrenal glands. Metabolism and action of catecholamine; Addison's disease and Cushing's syndrome. Structure and cell types of Islets of Langerhans. Insulin and Non-Insulin Dependent Diabetes mellitus; Islet cell tumour. Gastro-Intestinal Hormones: Gastrin, CCK and Secretin.	14
<b>References:</b> <ol style="list-style-type: none"> <li>1. An Introduction to Neuroendocrinology, Brown R., (1994), Cambridge University Press, Cambridge, UK</li> <li>2. Bolander .Jr F.F. (2004) Molecular Endocrinology Third Edition. Academic press. SanDiego.</li> <li>3. Endocrinology (3 volumes set), DeGroot L. J. and Jameson J.L., Editors, (5th Ed., 2006), Saunders Elsevier Press, USA.</li> <li>4. Fred H. Wilt and Sarah C. Hake, 2001. Principles of Developmental Biology, W.W. Norton &amp; Comp. Inc. NY. 2004.</li> <li>5. Goodman. H.M (2003). Basic Medical Endocrinology. Third Edition. Academic press. SanDiego.</li> <li>6. Lewis Wolpert, 2012. Principles of Development, Oxford Univ. PressSlack J. M.W. Essential Developmental Biology, Blackwell.</li> <li>7. Mary S. Tyler, 2000. Developmental Biology: A guide for experimental study, 2nd Edition, Sinauer Assoc. Inc. Sunderland, MA.</li> <li>8. Negi. C.S. (2009). Introduction to Endocrinology. PHI learning Pvt Ltd. New Delhi.</li> <li>9. Norris. D.O. (2006). Vertebrate Endocrinology. Third Edition. Academic press. SanDiego.</li> <li>10. Richard M. Twyman, 2001. Instant notes on Developmental Biology, Springer Verlag, BIOS Scientific.</li> <li>11. Scott F. Gilbert. 2014. Developmental Biology, 9th Edition, Sinauer Assoc. Inc. Sunderland, MA.</li> </ol>		

**DSC7: Ethology and Chronobiology**

<b>Course Title:</b> Ethology and Chronobiology	<b>Course code:</b> 24ZOO2C7L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Get knowledge about the different types of animal behaviour.
2. Impart knowledge about the different types of behaviour.
3. Gain basic understanding about endocrinology.
4. Communication in animals.
5. Gain knowledge about the endocrine glands and the diseases.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<b>Introduction to animal behaviour-</b> History of Animal behaviour- Karl Von Fritz, Tinbergen and Lorenz contribution- Methods for studying animal behaviour- Proximate and ultimate causation of behaviour- <b>Behavioural patterns-</b> Orientation, animal navigation and migration- Instinct Vs Learnt behaviour- Associative learning- Classical and Operant conditioning- Habituation, imprinting.	<b>14</b>
2	<b>Social behaviour and animal signaling-</b> Altruism- Honey bee, Vampire bats- Hamilton's rule, Kin Selection-Group foraging and its advantages- Dispersion- migration- territoriality. Animal Communication in birds, bees and wild mammals- Warning coloration, mimicry and deception. <b>Mating system-</b> Sexual dimorphism- Male- Male competition- Female choice- Leks- Alternative mating tactics-satellite males- monogamy- Polyandry- Polygyny- Sperm competition- Parental care.	<b>14</b>
3	<b>Chronobiology: Circannual rhythms</b> Introduction, History and Milestones, Clocks, Rhythm and Calendar, The biological timing system: Concepts and methods, Types: Ultradian, circadian and circannual rhythms. Proximate and Ultimate factors, Circannual control of seasonal processes, Photoperiodism: Concepts and photoperiodic time measurement models, Seasonal processes and photoperiodic control mechanisms. Human temporal structure: Biological clocks and human health and diseases, Clock dysfunction and lifestyle related disorders, Chronopharmacology, chronomedicine, chronotherapy.	<b>14</b>
4	Rhythm characteristics: Free running rhythms, Entrainment and masking in the natural and	<b>14</b>

artificial environment, <i>Zeitgebers</i> : Photic and non-photic, Parametric and non-parametric entrainment, Phase shift, Phase response curves (PRC) and phase transition curves (PTC).
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**References:**

1. An Introduction to Animal Behaviour (6th Edition). Aubrey Manning and Marian Stamp Dawkins, Cambridge University Press.
2. Animal Behaviour: An Evolutionary Approach, 9th Edition. John Alcock, Sinauer Associate Inc., USA, 2009.
3. Animal Behaviour (11th Edition). Dustin R. Rubenstein and John Alcock, Sinauer Associate Inc., USA, 2018.
4. Neuroscience of Emotion: A New Synthesis. Ralph Adolphs and David J. Anderson, Princeton University Press, 2018.
5. The Honey Bee. James L. Gould and Carol Grant Gould, Times Books, 2002.
6. The Wisdom of the Hive. Thomas D. Seeley, Harvard University Press, 1995
7. Honeybee Democracy. Thomas D. Seeley, Princeton University Press, 2010.
8. The Selfish Gene. Richard Dawkins, Oxford University Press, 2016.
9. Insect Clocks (3rd edition): D.S. Saunders, C.G.H. Steel, X. Afopoulou (ed.) R.D.Lewis. 2002 Barends and Noble Inc. New York, USA
10. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
11. Circadian Medicine: Christopher Colwell (ed.) Wiley-Blackwell (2015).
12. Circadian Physiology: Roberto Refinetti, CRC Press (3<sup>rd</sup>ed) 2016.
13. Biological Timekeeping: Clock, Rhythms and Behaviour, Vinod Kumar (ed. 2017) Springer India Pvt Limited.

<b>Course Title:</b> Cancer and Radiation Biology	<b>Course code:</b> 24ZOO2C8L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Understand terms in cancer biology.
2. Gain knowledge about basics of cancer biology.
3. Gain knowledge on various causes of cancer, signalling, immune response and treatment regimen.
4. Understand the molecular and cellular mechanisms that lead to cancer.
5. Understand various types of cancer, tumor invasion, markers in cancer research and diagnosis.
6. Demonstrate antigen-antibody relationships and their detection methods.
7. Knowledge of the fundamentals of radiation transport, interactions, design and safe operation of radiation equipment and systems.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<p><b>Cancer:</b> Definition, causes, properties, classification, prevalence, clonal nature. Cancer risk factors: Theory of carcinogenesis, Chemical carcinogenesis, Physical carcinogenesis: x-ray radiation – mechanisms of radiation carcinogenesis. Etiology of cancer: Stages of cancer: initiation, promotion, progression.</p> <p><b>Tumor immunology:</b> Adaptive and Innate immune response, immune-surveillance, immune recognition of tumors, tumor-specific transplantation antigens, tumor associated transplantation antigens, NK cell and tumor, role of T-regulatory cells in immune invasion.</p>	14
2	<p><b>Oncogenes and their role in Cancer:</b> Introduction to oncogenes, Mechanisms of oncogene activation (gene amplification), Mechanisms of oncogene activation (chromosomal translocations), Chromosomal translocations with dominant negative effects, Introduction to tumor suppressor genes.</p> <p>Cancer therapy – at cellular level- at gene level- at protein level. Principles of cancer biomarker and their applications – chemotherapeutics for cancer, Phytotherapy for cancer. Development of anti cancer drugs.</p>	14
3	<p><b>Current treatment regimen:</b> Development and clinical use of effective therapies, anti-cancer drugs and attractive targets for drug development, Screening of new drugs, various clinical trial phases (Phase I, Phase II,</p>	14

	Phase III), drug resistance and effective therapy.	
4	<b>Radiation Biology:</b> Introduction: Definition, scope and significance of radiation biology; General classification of radiation. Ionizing radiation: Linear energy transfer; radiation dose and units; principles of radiation dosimetry; direct and indirect effects. Cellular radiobiology: Radiobiological definitions of cell death; survival curves and models; cell cycle effects; relative biological effectiveness (RBE); cellular repair exemplified in survival curves; cellular hyper-radiosensitivity (HRS) and induced repair (IRR).	14
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Cancer Biology (Authors: Raymond W. Ruddon)</li> <li>2. The Biological Basics of Cancer(Author:<i>Robert Gilmore McKinnell et al</i>)</li> <li>3. Principles of Cancer Biology (Author:Lewis J. Kleinsmith)</li> <li>4. Biology of Cancer (Authors: Lobo D)</li> <li>5. Weinberg R.A.Biology of Cancer.TaylorandFrancisInc.</li> <li>6. The biology of cancer, Robert A. Weingberg, Garland Sciences, Taylor and Francis Group.</li> <li>7. The molecular biology of cancer, Stella Pelengaris and Michael Khan, Wiley-Blackwel</li> <li>8. Tannock IF and Hill RP(1998) The Basic Science of Oncology, Third edition, McGraw-Hill, New York.</li> <li>9. The Molecular Biology of Cancer: S. Pelengaris, M. Khan. Blackwell Publication. 2002</li> <li>10. The Cancer Hand Book: Malcolm R. Alison. Nature Publishing Group.</li> <li>11. The Biology of Cancer, Robert Allan Weinberg · 2014, Garland Science</li> <li>12. Anonymous, Radiation Biology: A handbook for teachers and students; International Atomic Energy Agency (IAEA), Training Course Series 42, Vienna.</li> <li>13. Steel GG, Basic Clinical Radiobiology, Amazon, UK.</li> </ol>		

**SEC 2: Non-clinical Safety Evaluation of Drugs**

<b>Course Title:</b> Non-clinical Safety Evaluation of Drugs	<b>Course code:</b> 24ZOO2S2LP
<b>Total Contact Hours:</b> 28 (01 L-0-2P)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1.5 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (COs):**

**At the end of the course, students will be able to:**

1. Gain the practical skills required to conduct the preclinical toxicity studies.
2. Know the pre-clinical and clinical development.
3. Study the various types of toxicity studies and their procedure.
4. Determine the various pharmacokinetic parameters from either plasma concentration or urinary excretion data for drug.
5. Use various experimental animals for the different toxicological studies.
6. Learn the importance of the role of computer aided drug design in drug discovery.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<p><b>Laboratory Animals and Regulatory Guidelines and Biostatistics in Drug Development</b></p> <p>Common laboratory animals: Description, handling and applications of different species and strains of animals. Environmental conditions. Maintenance and breeding of laboratory animals. Anaesthesia and euthanasia of experimental animals. CPCSEA guidelines to conduct experiments on animals. Regulatory guidelines for conducting toxicity studies OECD, ICH, EPA and Schedule-Y. OECD principles of Good laboratory practice (GLP) History, concept and its importance in drug development.</p> <p>Levene's test, ANOVA, Dunnett's test, non-parametric test (wilcoxon rank tests, analysis of variance, correlation, chi square test. Sample size, Experimental designing, control v/s treatment results.</p>	14
2	<p><b>Evaluation of Toxicity and Toxicokinetics</b></p> <p>LD50, LC50, IC50, EC50; Route of administration; Dose response relationship and its evaluation. Acute, sub-acute and chronic- oral, dermal and inhalational studies as per OECD guidelines. Skin sensitization, dermal irritation &amp; dermal toxicity studies. Test item characterization- importance and methods in regulatory toxicology studies. Reproductive toxicology studies, Male reproductive toxicity</p>	14

	<p>studies, female reproductive studies, teratogenicity studies and generation studies. Genotoxicity studies (Ames Test, in vitro and in vivo Micronucleus and Chromosomal aberrations studies). In vivo carcinogenicity studies. Principle of ecotoxicology; Terrestrial model and ecotoxicity testing: Earthworm, Honey bee, Birds, Plants; Aquatic models and ecotoxicity testing: Algae, Lemna, Daphnia, Brin shrim, Fish.</p> <p>Toxicokinetic evaluation in preclinical studies; Absorption, Digestion, Metabolism, Excretion. Saturation kinetics Importance and applications of toxicokinetic studies. Alternative methods to animal toxicity testing. Blinding, Randomization, and Stratification.</p>	
<p><b>References (indicative)</b></p> <ol style="list-style-type: none"> <li>1. David C. Young. Computational Drug Design. A guide for Computational and Medicinal Chemists. Wiley. 2009.</li> <li>2. Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed. 7 th; McGraw Hill; New York; 2007.</li> <li>3. <a href="#">Introduction to statistical methods with MATLAB (MATLAB and Simulink Training (mathworks.com))</a></li> </ol>		

**DSC5 P4: Biology of Chordates**

<b>Course Title:</b> Biology of Chordates	<b>Course code:</b> 24ZOO2C5P
<b>Total Contact Hours:</b> 56 (0-0-4P/week)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 4 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Dissect small fishes and show different parts.
2. Distinguish bones of different animal organisms.
3. Recognize migratory birds.
4. Outline the causes of extinction of animals.
5. To handle small animal organism without affecting their internal organs
6. Interpret anatomical differences among vertebrates.
7. Differentiate the organ systems in different vertebrates.
8. Perform preliminary survey on migratory birds.
9. Design the net for collecting fishes and identify different fishes.
10. Develop the aesthetic sense in protecting animal organisms.

<b>SL No</b>	<b>List of experiments</b>	<b>Hours</b>
1	Study of digestive system, respiratory system, arterial system, venous system and reproductive systems in different vertebrates (using charts/ videos / computer simulations). Specimen collection and preservation techniques.	4
2	Study of museum specimens.	4
3	Protochordata: Salpa, Doliolum, Herdmania, Amphioxus, Petromyzon	4
4	Fishes: Catla, Rohu, Mrigal, Calbasu, Silver carp, Grass carp, Mackerel, Sardine, Eel, Shark. Study of different scales of various fishes.	4
5	Study of fish anatomy of fry and fingerlings.	4
6	Amphibians: Study of Ambystoma, Axolotl larva, Ichthyophis. Parental care in Amphibia.	4
7	Reptiles: Outline differences between poisonous and non-poisonous snakes. Camouflage.	4
8	Birds: Study of Structure, mechanism, adaptation and development of feathers in different birds.	4
9	Osteology: Skull and lower jaws, types of vertebrae of procoelus, ophisthocoelus, amphicoelus, heterocoelus, axis and atlas vertebrae.	4
10	Comparative anatomy (models): Hearts and brains of vertebrates.	4
<b>References:</b>		

1. A manual of practical zoology, Chordates, Dr. P.S Verma, S. Chand Publications.
2. Advanced practical chordate zoology by G.S Sandhu and Harshavardhan.
3. Biology of chordates by B.N Pandey and Vartika Mathur, PHI Learning publishers.
4. Modern text book of zoology, by Dr. R.L Kotpal
5. Waterman. A.J. 1971. Chordate Structure and Function. McMillan Co. London.
6. Hyman, L.H. (1966): Comparative Vertebrate Anatomy. The University of Chicago Press. Jolie, M. 1968. Chordate Morphology. East West Press. Pvt, Ltd

<b>Course Title:</b> Developmental Biology and Molecular Endocrinology	<b>Course code:</b> 24ZOO2C6P
<b>Total Contact Hours:</b> 56 (0-0-4P/week)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 4 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (CO's):**

**At the end of the course, students will be able to:**

1. Learn basic principles of important techniques applied to neuroendocrine research.
2. Understand the role of androgens and estrogens in the prostate and breast cancer respectively.
3. Gain knowledge on relationship the actions of peptide hormones (e.g. insulin) and diseases (e.g. diabetes).
4. Understand the basic organization of the vertebrate brain, and the interaction of hypothalamus with the pituitary and pineal gland.
5. Understand neuroendocrine regulation of physiological processes.
6. Understand the molecular mechanisms of receptor activation and their biological effects.
7. Explain the molecular mechanisms by which peptide hormones activate cell surface receptors to provoke their biological effects.

**Developmental Biology and Molecular Endocrinology practicals**  
**Contents**

**Practical's:**

1. Mounting of developmental stages of chick embryo
2. Study of the developmental stages and life cycle of Drosophila from stockculture.
3. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
4. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
5. Project report on Drosophila culture/chick embryo development
6. Histological study of endocrine glands.
7. Paper chromatographic separation of corticoids
8. Case study relating to particular clinical conditions of hormone.

9. Dissect and display the endocrine glands in a fish\*
10. Dissect and display of Endocrine glands in laboratory bred rat\*

**\*Demonstration practical/ Dissection/Virtual dissection/Models/Chart of animal systems as per UGC guidelines.**

**References:**

1. Analysis of Biological Development, Kalthoff, (2nd Ed., 2000), McGrawHill Science, New Delhi, INDIA.
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Biochemical actions of hormones, ed. Litwack, G. (1985), Academic press, New York, USA
4. Carlson, R. F. Patten's Foundations of Embryology
5. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
6. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
7. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press
8. Molecular Biology of Steroid and Nuclear Hormone receptors, ed. Freedman L. P., (1998), Birkhauser, Boston, USA
9. Principles of Development, Wolpert, Beddington, Brockes, Jessell, Lawrence, Meyerowitz, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.

**DSC7 P6: Ethology and Chronobiology**

<b>Course Title:</b> Ethology and Chronobiology	<b>Course code:</b> 24ZOO2C7P
<b>Total Contact Hours:</b> 56 (0-0-4P/week)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 4 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Conceptualize how species profitably inhabit in the temporal environment and space out their activities at different times of the day and seasons.
2. Understand the historical foundations of the field, as well as current theories and evidence for a broad range of behavioral topics.
3. Develop a critical viewpoint and to interpret observations from experiments on biological rhythms regulating daily and seasonal biology.
4. Plan studies on biological rhythms in both human and non-human species.
5. Understand the consequence of the disruption of internal rhythms on work performance and health in the modern world.

SL No	List of experiments	Hours
	<b>Ethology</b>	<b>4</b>
1	To study the geotaxis, phototaxis, chemotaxis and hydrotaxis of earthworm.	4
2	To study the response of woodlice to hygrostimuli.	4
3	Fixed action pattern in spider.	4
4	Habituation in snail.	4
5	Behaviour observations in a primitive eusocial wasp.	4
6	Courtship and mating behaviour in <i>Drosophila</i> .	4
7	Foraging behaviour in a (Myna bird).	4
8	Behavioural profiling of a primate <i>Macaca muleta</i> .	4
9	Territorial behavior in stray dogs.	4
10	Any other experiments nearby area related to syllabus	4
	<b>Chronobiology</b>	
10	Assay of circadian rhythms using animal model systems.	4
11	Assay of circadian activity rhythms in human.	4
12	Ambulatory blood pressure monitoring and circadian analysis.	4
13	Quantifying oscillations: phase, period and amplitude.	4
14	Dry lab exercises on the previously recorded data.	4

15	Recording of body temperature (T <sub>b</sub> ) of human.	4
16	Experiments demonstrating the photoperiodic clock.	4

**References:**

1. Animal Behaviour: An Evolutionary Approach, 9th Edition. John Alcock, SinauerAssociate Inc., USA, 2009.
2. Animal Behaviour (11th Edition). Dustin R. Rubenstein and John Alcock, SinauerAssociate Inc., USA, 2018.
3. The Honey Bee. James L. Gould and Carol Grant Gould, Times Books, 2002.
4. Chronobiology Biological Timekeeping: Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
5. Biological Timekeeping: Clock, Rhythms and Behaviour, Vinod Kumar (ed. 2017) Springer India Pvt Limited.
6. Circadian Physiology: Roberto Refinetti, CRC Press (3<sup>rd</sup>ed) 2016.

**CBCS Question Paper Pattern for M.Sc. Zoology Semester End Examination with  
Effect from the AY 2024-25**

**Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)**

**Paper Code:**

**Time: 3 Hours**

**Note: Answer any FIVE of the following, each question carries equal marks Question No.1 is Compulsary.**

**Paper Title:**

**Max. Marks: 70**

Q1.	A	7 Marks
	B	7 Marks
Q2.		14 Marks
Q3.		14 Marks
Q4.		14 Marks
Q5.		14 Marks
Q6		14 Marks
Q7		14 Marks
Q8	A	7 Marks
	B	7 Marks

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**Skill Enhancement Courses (SECs)**

**Paper Code:**

**Time: 1 Hours**

**Paper Title:**

**Max. Marks: 30**

**There shall be Theory examination of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.**

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## **Question Paper Pattern for Subjects with Tutorial**

**For the subjects with Tutorial component, there is no Semester-End Examination (SEE) to the component C3. The liberty of assessment of C3 is with the concerned faculty. The faculty must present innovative method of evaluation of component C3 before the respective BoS for approval and the same must be submitted to the Registrar and Registrar(Evaluation) before the commencement of the academic year.**

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**VIJAYANAGARA SRI KRISHNADEVARAYA  
UNIVERSITY**

**JNANASAGARA CAMPUS, BALLARI-583105**

**Department of Studies in Zoology**

**SYLLABUS**

**Master of Science  
(III Semester)**

**Effective from  
2024-25**

**Distribution of Courses/Papers in Postgraduate Programme III Semester as per Choice Based Credit System (CBCS) Proposed for PG Program in  
Zoology  
III-SEMESTER**

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	SEE	Total	L	T	P		
<b>THIRD</b>	DSC9	24ZOO3C9L	Reproductive Biology and Artificial Organs	30	70	100	4	-	-	4	3
	DSC10	24ZOO3C10L	Environmental Biology	30	70	100	4	-	-	4	3
	DSE1	24ZOO3E1AL	A) Human Physiology	30	70	100	4	-	-	4	3
		24ZOO3E1BL	B) Biophysics and Biostatistics								
		24ZOO3E1CL	C) Parasitology, Evolutionary Biology and Paleozoology								
	DSE2	24ZOO3E2AL	A) Immunology, Proteomics and Genomics	30	70	100	4	-	-	4	3
		24ZOO3E2BL	B) Biochemistry and Enzymology								
		24ZOO3E2CL	C) Neurobiology and Aging								
	GEC1	24ZOO3G1AL	A) Wild life conservation and management	20	30	50	2	-	-	2	1
		24ZOO3G1BL	B) Entrepreneurial Zoology								
		24ZOO3G1CL	C) Hormones and Diseases								
SEC3	24ZOO3S3LP	Research Methodology	20	30	50	1	-	2	2	2	
DSC9P7	24ZOO3C9P	Reproductive Biology and Artificial Organs Lab	20	30	50	-	-	4	2	4	
DSC10P8	24ZOO3C10P	Environmental Biology Lab	20	30	50	-	-	4	2	4	
<b>Total Marks for III Semester</b>						<b>600</b>				<b>24</b>	

**Department Name: Zoology**  
**Semester-III**

**DSC9: Reproductive Biology and Artificial Organs**

<b>Course Title:</b> Reproductive Biology and Artificial Organs	<b>Course code:</b> 24ZOO3C9L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):**

**At the end of the course, students will be able to:**

1. Understand which factors determine the sex and phenotypic differentiation of the fetus
2. Compare and contrast the structure and functions of the male and female reproductive system. Significance of hormones in pregnancy, parturition and lactation.
3. Analyze the reasons for male and female infertility and narrate about the contraceptives
4. Know the importance of diet, exercise, stress and yoga during ageing.
5. Gather the knowledge about the principles, construction and control algorithms of artificial organs. Student knows the main features of biomaterials and the biocompatibility phenomena.
6. Know state of the art in Artificial Organ domain.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	Sex determination and differentiation: Mechanism of Sex determination, differentiation of gonad and the genital tract. Stem cell renewal in testis Spermatogenesis: structural and molecular events, experimental approaches to study spermatogenesis; Seminiferous epithelial cycle Sertoli cell: structure and function Leydig cell: generation of Leydig cell Steroidogenesis; Leydig and Sertoli cell proliferation during foetal and postnatal development; Regulation of testicular functions.	14
2	Functional morphology and hormonal regulation of male reproductive organs: Epididymis, Vas deferens, Prostate gland, Seminal vesicle, Coagulatory- gland, Cowper's gland Biochemistry of semen and biology of spermatozoa	14

	<p>Anatomy of female reproductive system: Histoarchitecture of ovary, Folliculogenesis, Follicular atresia</p> <p>Mechanism of ovulation, Luteogenesis, Luteinization, Luteolysis and Luteal function</p> <p>Physiological role of estrogens</p> <p>Estrous cycle in mammals and its hormonal regulation</p> <p>Menstrual cycle and its hormonal regulation.</p> <p>Female reproductive disorder: amenorrhea, polycystic ovary.</p>	
3	<p>Implantation: Types of implantation, sequence of events during implantation, decidual cell reaction, delayed implantation, cell adhesion molecules, growth factors, hormonal regulation.</p> <p>Placenta: Types and functions, developmental and physiologic anatomy, Placental hormones.</p> <p>Pregnancy: Corpus luteum, physiological changes during pregnancy, endocrine control of pregnancy, disorders of pregnancy.</p> <p>Parturition: onset of parturition, stages of labor, hormonal control of parturition.</p> <p>Lactation: Morphological and functional development of mammary glands. Hormonal control of lactation.</p> <p>Reproductive technologies: In vitro fertilization. Gamete intrafallopian transfer. Surrogate pregnancy, gestational carrier. Fertility control in male and female.</p> <p>Age related reproductive disorders: Perimenopause, premenopause, postmenopausal disorders</p> <p>Effect of diet, nutrition, stress, disease, exercise, and yoga on reproductive aging.</p>	14
4	<p>Design of artificial organs: substitutive medicine, Biomaterial Concentration, Outlook for Organ Replacement, Design Consideration, Evaluation of Artificial Organs.</p> <p>Artificial blood: Artificial Blood: Plasmapheresis, Blood Substitutes, Hemodilution, Classification, Characterisation of substitutes.</p> <p>Artificial Liver: Liver Support Systems, Global Liver Function Replacement, Hybrid Liver Function Replacement.</p> <p>Artificial kidney: Renal Transplantation, Mass Transfer in Dialysis, Membranes, Hemofiltration, Peritoneal Dialysis Equipment.</p>	14

**References:**

1. Guyton and Hall. Text book of medical physiology, 2006.
2. Bentely, P.J. *Comparative Vertebrate Endocrinology-UI* Ed, Cambridge University Press, 1998.
3. Degroot, L.J. & Neill, J.D. (Eds). *Endocrinology Vol I-III* W.B. Saunders Co, 2001.
4. Hadley. Mac. E. *Endocrinology*. Prentice Hall International Inc, 1992.

5. Knobil, E and Neill, J.D. (Eds). Encyclopedia of Reproduction. Vol. I-IV. Academic Press, 1998.
6. Knobil, E and Neill, J.D. (Eds). The Physiology of Reproduction II. Vol I and II. Raven Press Ltd, 1994.
7. Press Ltd, 1994.
8. Mandal, A. Handbook of Neuroendocrinology. EMKAY Publications, 1994.
9. Nelson, R.J. An Introduction to Behavioural Endocrinology. Sinauer Associates Inc, 1995.
10. Turner, CD and Bagnara, J.T. General and Comparative Endocrinology, 1998.
11. Williams, RM. Textbook of Endocrinology. W.B. Saunders.
12. Martin, C.R Endocrine Physiology. Oxford University Press.
13. Saidapur.S.K. (Ed). Reproductive Cycles of Indian Vertebrates. Allied Publishers Ltd. New Delhi, 1989.
14. 'Tissue Engineering and Artificial Organs' By Joseph D.Bronzino.
15. "Artificial Organs" by Gerald E.Miller Morgan & Claypool Publisher.

**DSC10: Environmental Biology**

<b>Course Title:</b> Environmental Biology	<b>Course code:</b> 24ZOO3C10L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Understand the critical issues facing the environment at local, regional, national and global scales
2. Prepares students as professional biologists with strong environment emphasis.
3. To gain the scientific perspective of the issues confronting our present day environment.
4. Analyze the national and global environment issues relating to atmosphere, water, soil and land use, biodiversity and natural resources (global warming, climate change, mineral extraction, and energy resources, environmental impact assessment)

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	Our Environment: Development and evolution of ecosystem; Energy flow in ecosystem: Food chain, food web; Trophic structure and energy pyramids; ecological energetic (brief account). Hydrologic cycle; Biogeochemical cycles (N, C, P cycles). Natural resources; Renewable and Non –renewable resources. Forest resources; use and overexploitation; deforestation; conservation and sustainable management. Water resource; use and overutilization of surface and ground water; Floods; Drought; Conflicts over water usage; Dams -benefits and problems; conservation and sustainable management.	14
2	Food resources: World food scenario; Effects of modern agriculture; Fertilizer–pesticide problems Land resource: Land classification and use ; Land degradation induced landslides, soil erosion, desertification. Mineral resources (Metallic and Nonmetallic): Distribution, utilization, conservation and management. Energy resources: Conventional and non-conventional resources; Growing energy needs and sustainable management.	14
3	Environmental pollution: definition, causes, effects and control measures of:- i) Air Pollution, ii) Water Pollution,	14

	iii) Soil pollution, iv) Noise pollution v) Thermal Pollution vi) Nuclear hazards Solid waste management; Causes, Effects and control measures. Biomedical waste management: Causes, effects and control measure Human ecology: values and ethics of human environment; Population growth and related issues; Environment and human health; Human rights.	
4	Toxic Pollutants and their impact on non-target flora, fauna and humans. Biodegradation, biotransformation, biomagnification and bioaccumulation of toxicants. Biological indicators and monitoring. Disaster management: Floods, Earthquake, Cyclone and Landslides. Climate change – global warming, Ozone layer depletion, acid rain. Environment and Social issues: Resettlement and rehabilitation of people Waste land reclamation Environmental ethics. Environmental awareness; environmental education - role of educational institutes and Other agencies. Environmental Protection Act and related Acts <b>Sustainable development Goals (SDG's) related to ecology.</b>	14

**References:**

1. Willmer,P., Stone. Gand Johnston,I. Environmental Physiology of animals. Blackwell Science Ltd.
2. Mckinney, M.L and Schoch, R.M. Environmental Science: Systems and Solutions. Jones & Bartlett Publishers, 1998.
3. Cunningham, W.P. Environmental Science-V Ed. WCB McGraw Hill, 1999.
4. Clesceri, L.S., Greenberg, A.E and Eaton. A.D. Standard Methods for the Examination of Water & Waste Water-XX Ed. American Public Health Association, 1998.
5. Arora, R.K. Air Pollution. Causes & Effective control. Mangal Deep Publications, Jaipur, 1999.
6. Chakraborti, N.K. Environmental Protection and Law.1994.
7. Chitkara, M.G. Encyclopedia of Ecology, Environment and Pollution. Vol. IXIII, 1997.
8. Chapman, J. L. and Reiss, M. J. Ecology: Principles and Applications. Cambridge University Press, 1999.
9. Eldon, D Enger and Bradly F. Smith. Environmental Sciences, 1995.

**DSE1: A) Human Physiology**

<b>Course Title: A) Human Physiology</b>	<b>Course code: 24ZOO3E1AL</b>
<b>Total Contact Hours: 56</b>	<b>Course Credits: 04</b>
<b>Formative Assessment Marks: 30</b>	<b>Duration of ESA/Exam: 3 h</b>
<b>Summative Assessment Marks: 70</b>	

### Course Outcomes (CO's):

#### At the end of the course, students will be able to:

1. Understand human physiological processes
2. Draw and explain the role of organs in various organ systems
3. Determine blood grouping of unknown blood samples
4. Relate the association between different organ systems in man
5. Describe and analyse functioning mechanism involved in human body
6. Measure the degree of health based on physiological malfunctions

Unit	Description	Hours
1	Introduction to physiology, Levels of organization, Cell physiology, Homeostatic mechanism of major functional systems. Solubility of gases. Physiology of sense organs. Components of Integumentary system and its function. The immune system: Lymphatic system, three defense against infection and disorders. Digestive system: Functional morphology of GI tract, physiology of digestion and absorption, nutritional requirements.	14
2	Body temperature and energy metabolism, metabolic disorders, GI disorders. Respiratory system: Respiratory organs. Physiology of respiration: transport of gases, lung capacity, regulation of blood pH, Respiratory system disorders. Circulatory system: Human heart, physics of pressure, flow and resistance. Cardio-vascular pathways, cardiac cycle, electric conduction system, ECG, BP and Cardio-vascular diseases. Blood and body fluids, blood composition, hemostasis, blood transfusion. Aging and heart, lymph and vascular system.	14
3	Excretory system: Organs of urinary system, Physiology of excretion, renal failure, dialysis, renal disorders. Nervous integration in brief: Neuron structure, classification and properties. Conduction of nerve impulse in myelinated and non-myelinated neurons, synapse, neurotransmitters. The limbic system and higher mental system. Drug abuse and disorders of nervous system. Muscular and skeletal system: Physiology of muscle movement, skeleton, biomechanics and muscle disorders.	14
4	Nutrition and health: balanced diet, nutritional requirements of carbohydrates, proteins, lipids, minerals and vitamins. Dose indication & nutritional disorders. Biosynthesis and inter-convertibility of fuel molecules: glycogen, fats & amino acids. Regulation of metabolism.	14

#### References:

1. Guyton A C and Hall J E.2006. Text book of medical physiology. 11<sup>th</sup> edition, Saunders, Philadelphia, USA
2. Martini FH and Nath JL. 2009. Fundamentals of anatomy and physiology. Pearsons Benjami, Cummings. USA
3. Bipin kumar. 2001. Human Physiology. Campus books international, New Delhi.
4. Sarada Subramanyam and Madjavankutty. Text book of Human Physiology revised by

H.D Singh, S. Chand Publishers.

5. Anne Waugh and Allison Grant. Ross and Wilson- Anatomy and Physiology in health and illness. 14<sup>th</sup> edition, Elsevier.
6. Cindy Stanfield. 2010. Principles of human physiology 4<sup>th</sup> edition.
7. Ranade VG, PN Joshi and Shalini Pradhan. 1982. A text book of practical physiology, PVG Prakashan, Pune.
8. Knut Schmidt- Nielsen. Animal Physiology: Adaptation and environment. Cambridge University Press.
9. Richard Hill, Gordon Wyse and Margaret Anderson. Animal Physiology. Sinauer Associates, Inc. Publishers. Sunderland, Massachusetts.
10. Valerie C. Scanlon and Tina Sanders. Essentials of anatomy and physiology, fifth edition.

**DSE1: B) Biophysics and Biostatistics**

<b>Course Title:</b> B) Biophysics and Biostatistics	<b>Course code:</b> 24ZOO3E1BL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Define variables used in the statistics methodology
2. Apply the statistical methods in everyday chores and in basic research
3. Relate physical principles with the life processes
4. Perform statistical analysis using precise tools and techniques
5. Calculate and infer results using software techniques

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<b>Biophysics:</b> The system concept, ten pillars: variables: variable, function, limits, increments, instantaneous rate of change, the differential and integral calculus, distribution of observations, expression of deviations, indices & log and infinite series. Physical forces: mechanical, osmotic and electrical. <b>Radioactivity:</b> Biotraces – ionization, disintegration, penetration and their uses. Matter waves, sound and ultrasound: properties, Weber-Fechner law, ear, mechanoreceptors. Physiological effects of intense matter waves and their applications. Neurosonic surgery.	14
2	<b>Electromagnetic radiations and matter:</b> structure of matter, EM radiations, interaction of EM radiations and living matter. Microscopy: Interference, phase-contrast and electron microscopy and their uses. <b>Bioenergetics:</b> laws of thermodynamics, drive towards equilibrium, Redox- system, measurement of $\Delta H$ , $\Delta F$ and $T\Delta S$ . Membrane potential, negative entropy change in living systems.	14
3	<b>Biostatistics:</b> Introduction to biostatistics, analysis of biological data, types of variables, probability. Hypothesis testing, confounding variables: randomizing, matching and statistical control. <b>Tests for nominal variables:</b> Chi-square test, G-test of goodness-of-fit, G-test of independence, Fischer's exact test, Cochran-Mantel-Haenszel test for repeated tests of independence. <b>Descriptive statistics:</b> Measures of central tendency, Statistics of dispersion, standard error of the mean and confidence limits, Tabulation and graphical representations.	14

4	<p><b>Tests for one measurement variable:</b> student's t-test for one and two samples, independence, normality, homoscedasticity and heteroscedasticity, data transportation. One way ANOVA, nested ANOVA, two way ANOVA, paired t-test and Wilcoxon signed rank test.</p> <p><b>Regression:</b> Correlation of linear regression, Spearman rank correlation, curvi-linear regression. Analysis of covariance, Multiple regression, simple logistic regression and multiple logistic regression.</p> <p><b>Multiple tests:</b> Multiple comparisons and meta analysis.</p> <p>Basic operations of biostatistics tools and techniques: SPSS, MATLAB, MS-EXCEL, MINITAB and Graph pad PRISM.</p>	14
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**References:**

1. E J Casey. Biophysics: concepts and mechanisms. Reinhold publishing corporation, New York.
2. John McDonald. Handbook of Biological Statistics. Third edition, Sparky House Publishing, Baltimore, Maryland, USA.
3. Gerald Belle et al. Biostatistics: A methodology for the health Sciences. Second edition, Wiley Interscience, A John Wiley and sons inc. Hoboken, New Jersey.
4. Siegmund Brandt. Data Analysis: Statistical and computational methods for scientists and engineers. Fourth edition, Springer.
5. Stephen Looney. Biostatistical methods, volume 184. Humana Press, Totowa, New Jersey.
6. Wayne W Daniel. Biostatistics: a foundation for analysis in the health sciences.
7. Christian Heumann and Michael Schomaker Shalabh. Introduction to statistics and data analysis, Springer.
8. Massimiliano Bonamente. Statistics and analysis of scientific data, second edition, Springer.

**DSE1: C) Parasitology, Evolutionary Biology and Paleozoology**

<b>Course Title:</b> C) Parasitology, Evolutionary Biology and Paleozoology	<b>Course code:</b> 24ZOO3E1CL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Outline classification of different parasites
2. Evaluate diseases based on disease etiology
3. Develop aesthetic sense of nature and develop a sense of commitment to protect nature and biodiversity
4. Forecast based on the theories of evolution of life span and ageing,
5. Illustrate and assess fossils based on carbon dating

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<b>Parasitology:</b> Origin and evolution of parasitism. Outline classification of pathogenic microbes. Types of hosts and parasites, effects of parasites on hosts. Food and water borne diseases. STDs, Disease etiology, epidemiology, pathogenicity, diagnosis, prophylaxis and therapeutic treatments <b>Pathogenic protozoa:</b> Amoebiasis, Kala-azar and Giardiasis. Pathogenic nematodes: Etiology of Wuchereria and Ascaris. Arthropods as parasites and vectors: life cycle of mosquitoes, ticks and mites, housefly and roach. Chemical and biological control measures.	14
2	<b>Evolutionary biology:</b> Overview of landmarks in evolutionary biology. Biopoiesis. Evolution through ages. Evidences of organic evolution. Evolution of man. Recent developments in Lamarckian concepts. Evolution of sex, evolution of inbreeding and outbreeding. Darwinism: Contributions of Charles Darwin and Neo-darwinism.	14
3	Origin of higher categories: Phyletic gradualism, punctuated equilibrium and adaptive walks on rugged landscapes. Micro and macro evolution. Evolution of life histories: evolution of age and size at maturation. Life history tradeoffs - optimality arguments and trade off surfaces with evidences. Evolution of clutch, size and reproductive investment. Evolution of life span and ageing.	14
4	<b>Paleozoology:</b> Survey of life through different geological time scale. Formation and types of fossils and fossilization. Taphonomy. Assessment of fossil records. Carbon dating of fossils, trace fossils and	14

	living fossils. Significance of fossils, geological time scale and associated fauna.	
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**References:**

1. Alpheus S Packard. A text book of Entomology: the anatomy, physiology, embryology and metamorphoses. Mac Milan Company, London.
2. CK Jayaram Panniker. Text book of medical parasitology, edited by Sougata Ghosh. 8th edition.
3. Margherita Raineri and Erki Tammiksaar. Evolutionary biology: Exobiology and evolutionary mechanisms. Edited by Pierre Pontarotti. Springer
4. Mary Ann Clark, Jung Choi and Matthew Douglas. Biology 2e. Openstax, Texas.
5. Richard and Kliman. The Encyclopedia of Evolutionary biology.
6. Quantitative paleozoology, Cambridge Press.
7. David Raup and Steven Stanley. Principles of Palentology-Second edition.
8. Susan Gray. 2012. Palentology: a study of pre-historic life. Childrens press.

**DSE2: A) Immunology, Proteomics and Genomics**

<b>Course Title:</b> A) Immunology, Proteomics and Genomics	<b>Course code:</b> 24ZOO3E2AL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Understand the role of different immune cells and their function
2. Developed ideas on immune dysfunction and their consequences
3. Emphasises on the development of the immune system and mechanisms by which our body elicit the immune response.
4. Acquire knowledge and understanding of fundamentals of genomics and Proteomics.
5. Study about transcriptomics and metabolomics and their applications in various applied areas of biology.
6. Evaluate the usefulness of immunology in different pharmaceutical companies.
7. Apply their knowledge and design immunological experiments to demonstrate innate, humoral or cytotoxic T lymphocyte responses.
8. Explain principles of basic methods of genomic and proteomic analysis

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<p>Acquired immunity: Naturally acquired, artificially acquired and adaptive, Humoral and cell mediated immunity. Immunogens, haptens; Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness and disease susceptibility. Biology of cells of the immune system: Hematopoiesis, Microphages (Neutrophils), Macrophages, T-Lymphocytes, B-Lymphocytes, Dendritic cells and NK cells. B cell maturation, activation and differentiation; T-cell maturation, activation and differentiation and T-cell receptors. Cancer immunotherapy; autoimmune disorder; NK cells in chronic viral infection and malignancy.</p> <p>Antigen-antibody interactions Precipitation, agglutination and complement mediated immune reactions; advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, immuno fluorescence microscopy, flow cytometry and immunoelectron microscopy; CMI techniques: lympho-proliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.</p>	14

2	Importance of proteomics, Separation technique- 2DPAGE, 2-DE (BN-PAGE), image analysis, Mass- spectrophotometry, LC-TMS, MALDI, and SALDI. Protein interaction, DNA- Protein interaction, Yeast two hybrid system and their applications.	14
3	Databases and search engines in proteomics, Protein-Protein interactions – Protein microarrays. Disease related proteins and drug discovery, Disease diagnosis, identification and characterization of novel proteins, protein engineering principles, techniques of proteomics in cancer research.	14
4	Introduction to Genomics, Anatomy of prokaryotic and eukaryotic genome, content of genome, C value paradox, repetitive DNA, tools to study genome diversity (PCR/ RFLP). Genetic maps, physical maps, EST and transcript maps, functional maps, comparative genomics and collinearity/syteny in maps. Genomics in medical practice, personalized medicine, DNA polymorphism and treatment of diseases.	14

**References:**

1. Abul K. Abbas, Andrew H. H. Lichtman, and Shiv Pillai, Cellular and Molecular Immunology. 9th Edition.
2. Paul, W. E. 2012. Fundamental Immunology. New York: Raven Press.
3. Brown T. A. 2007, Genomes 3. Garland Science Publishing, New York.
4. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific
5. Primrose, S. B., and R. M. Twyman. 2006. Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.
6. Murphy, K., Travers, P., Walport, M., & Janeway, C. 2012. Janeway's Immunobiology. New York: Garland Science. Paul, W. E. 2012. Fundamental Immunology. New York: Raven Press
7. Proteomics Research: New Frontiers in Functional Genomics (Principles and Practice) 1997. Edited by M.R. Wilkins. K.L. Williams, R.D. Apel and D.F. Hochstrasser, Springer Verlag, New York.
8. 2-D Proteome Analysis Protocols Edited by Andrew J. Link, 1998. Humana Press.

**DSE2: B) Biochemistry and Enzymology**

<b>Course Title:</b> B) Biochemistry and Enzymology	<b>Course code:</b> 24ZOO3E2BL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Students can get the detailed knowledge in enzyme activity and kinetics.
2. Understand the mechanism of action and regulation and about the way of enzyme application and exploitation
3. Expose students to various laboratory techniques in areas of biochemistry.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	Basic principles, instrumentation and applications of microscopy. Bright field, phase-contrast, fluorescence and confocal microscopy. Electron microscope – scanning and transmission electron microscopy. Blotting techniques: Western, Southern and Northern blotting: principle and methodology. PCR- conventional, reverse-transcriptase and real-time PCR. Primer designing and sequence analysis. Structure of monosaccharide's, oligosaccharides and polysaccharides, glycoproteins and glycolipids. Structure and properties of fatty acids, storage and membrane lipids, phospholipids and cholesterol, Composition and synthesis of lipoproteins and their transport in the body.	16
2	Structure, composition and properties of nucleic acids. Structure and properties of amino acids, Structure of protein (Primary, Secondary, Tertiary and Quaternary), essential and non-essential amino acids. Structure and properties of vitamins, co-enzymes. Biosynthesis of vitamins, role of vitamins in the metabolism. Disorders of Carbohydrate Metabolism – Diabetes mellitus, glucose and galactose tolerance tests, sugar levels in blood, glycogen storage diseases, pentosuria, galactosemia. Disorders of Lipids – Plasma lipoproteins, cholesterol, triglycerides & phospholipids in health and disease, hyperlipidemia. Inborn Errors of Metabolism – Phenylketonuria, albinism, maple syrup urine disease, sickle cell anemia, Histidinemia. Disorders of liver and kidney – Jaundice, fatty liver, normal and abnormal functions of liver and kidney.	14
3	Nomenclature and classification of enzymes according to I.U.B.	12

	Convention, specificity and active site. Isolation and purification of enzymes. Active site - determination of active site amino acids - chemical probe, affinity label, and site-directed mutagenesis, intrinsic and extrinsic regulations. Coenzymes - prosthetic group, classification - vitamin and nonvitamin coenzymes, folate coenzymes, coenzyme role of vitamin B12.	
4	Enzyme specificity, Mechanism of enzyme action - general acid-base catalysis, covalent catalysis, mechanism of serine proteases - chymotrypsin, lysozyme, and ribonuclease. Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production. Enzymes as thrombolytic agents, antiinflammatory agents, digestive aids. Therapeutic use of asparaginase, streptokinase.	14

**References:**

1. Dixon, M., and E. C. Webb. "Enzyme inhibition and activation." *Enzymes* 3 (1979): 126-136.
2. Palmer, T. *Understanding Enzymes*, 4th ed., Prentice Hall/Ellis Horwood, London (1995).
3. Price, Nicholas C., and Lewis Stevens. *Fundamentals of Enzymology*. Oxford Science Publications. Second edition. New York, 2001.
4. Buchholz, Klaus, Volker Kasche, and Uwe Theo Bornscheuer. *Biocatalysts and enzymetechnology*. John Wiley & Sons, 2012.
5. Copeland, Robert A. *Enzymes: a practical introduction to structure, mechanism, and data analysis*. John Wiley & Sons, 2004
6. Voet D., Voet J.G, *Biochemistry* 4th Edition. John Wiley and Sons, 2011.
7. Nelson, D. C. and Cox, M.M., *Lehninger Principles of Biochemistry*, 5th Edition, W. H. Freeman, 2010.
8. Berg J.M., Tymoczko J.L. and Stryer L., *Biochemistry*. 7th edition, W.H. Freeman and Co. New York, 2011.
9. Wilson, Keith, and John Walker, eds. *Principles and techniques of biochemistry and molecular biology*. Cambridge university press, 2010.
10. Bisen, Prakash Singh, and Anjana Sharma. *Introduction to instrumentation in life sciences*. CRC Press, 2012.

**DSE2: C) Neurobiology and Aging**

<b>Course Title:</b> C) Neurobiology and Aging	<b>Course code:</b> 24ZOO3E2CL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Understand the challenges that an aging population poses to the society and the economy.
2. Understand the impact of aging on the metabolism. This includes recognizing major effects of starvation and the role that caloric restriction has in prolonging lifespan.
3. Understand the major mechanisms of aging including telomere shortening, increased free radicals, DNA methylation etc.
4. Understand the role of biomarkers of aging.
5. Recognize the most common techniques used in research and clinic to measure anatomical effects of aging with particular emphasis on the brain.
6. Recognize changes in cognitive performance and executive function in aging patients.
7. Understand the major clinical features of neurodegenerative diseases.
8. Describe the role of depression in neurodegenerative disease and its management.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	Gross anatomy of adult brain, organization of the nervous system, subdivision of the nervous system, concept of CNS, ANS & PNS, meninges. The scalp, skull, meninges and cerebrospinal fluid, vertebral column, cutaneous nerve supply of head and neck limb and trunk.	12
2	Neurons and glial cells, Resting Potential & Action potential, Propagation of Nerve Impulses, Degeneration & regeneration /repair of nerve fibers. Pain production, pathways and analgesics, head ach & referred pain. Integrative functions of thalamus, cerebellum, basal ganglia & Cerebral cortex. Blood brain barrier, Blood CSF barrier, Spit Brain, EEG.	14
3	Neurophysiological basis of sleep, wakefulness. Learning, Memory, Emotion & Speech. Sleep disorders. Memory retrieval, Amnesia, Mood Disorders, Schizophrenia, Depression, Aphasia, stress management. Neuroimaging –CT, MRI, Mylography; Interventional Radiology – PET(Positron Emission Tomography) – CVA, Epilepsy, etc., Single - Photon Emission Computed Tomography, MR Spectroscopy, Magnetic Source imaging.	14

4	<p>Effect of Ageing on the brain function. Biological changes of ageing, Ageing theories, Ageing process Psychosocial aspects of ageing, Age related changes, Personality changes, Social changes, Changes in family and living arrangement, Depression, Coping with psychosocial changes of aging. Energy needs of old, Formulation of diet for elderly, Diet related degenerative changes, Physical activity.</p> <p>Fever, Anaemia, Vertigo, Anorexia, Loss of memory, Respiratory disease, Heart disease, Kidney disease, Stroke, Musculoskeletal disorder, CNS related health Problem, Digestive problem, Vision, Hearing, Sleep disturbances, Perimenopausal problem</p>	16
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**References:**

1. Theoretical Neuroscience – Computational and Mathematical Modeling of Neural System by Dayan and Abbot, 1st Edition, The MIT Press, 2001.
2. Neuroinformatics for Neuropsychology by Vinoth Jagaroo, Springer, 2009.
3. Neuroinformatics by Chiquito Joaquim Crasto, Humana Press, 2007.
4. Neuroinformatics: an overview of the Human Brain Project by Stephen H. Koslow, Michael F. Huerta, Routledge, 1997.
5. Gwyther, L.P. (2000). Family issues in dementia: Finding a new normal. *Neurologic Clinics*, 18, 993-1010.
6. Barnes, C.A. (1998). Memory changes during normal aging: Neurobiological correlates. In: J. Martinez and R. Kesner (Eds), *Neurobiology of Learning & Memory* (pp. 247-287). San Diego, CA: Academic Press.
7. Astur, R.S. (2002). Humans with hippocampus damage display severe spatial memory impairments in a virtual Morris water task. *Behavioural Brain Research*, 132, 77-84.
8. *Basic Geriatric Nursing*, Gloria Hoffman World, Edition 5, Illustrated Publisher Mosby 2011.
9. *Principle and practice of geriatric Medicine*, M. S. John Pathy, Alan J. Sinclair, John E. Morley

**GEC1: A) Wild life conservation and management**

<b>Course Title:</b> A) Wild life conservation and management	<b>Course code:</b> 24ZOO3G1AL
<b>Total Contact Hours:</b> 28 (02 L-0-0)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (COs):****At the end of the course, students will be able to:**

1. Understand historical aspects of Wildlife conservation in India and India's conservation present day conservation priorities.
2. Undertake situation analysis for conservation.
3. Understand and practice applications of emerging tools and techniques in wildlife conservation.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	Brief Details of: Introduction, importance of wild life conservation – Economic, ecological, aesthetic, Scientific, Recreational, Medicinal. Wild life categories: Endangered, Threatened, Vulnerable, rare; data deficient categories, Red data book. Causes of wildlife depletion: Degradation and destruction of natural habitats, Exploitation for commercial purposes, Deforestation, Agricultural expansion and grazing, Urbanization and industrialization, Forest fires. National parks, Wildlife sanctuaries, wildlife reserves, privately owned wildlife reserves & Biosphere reserves, Single species / single habitat based conservation programmes (e.g. Project tiger, Project Elephant, Valley of flowers, etc..) Umbrella species, flagship species. International conventions on conservation ; Important International conventions & treaties on nature & conservation, India's role & contribution.	14
2	Ex- situ & in-situ conservation, Conservation Breeding (e.g. Vulture, Pygmy hog, Gharial etc.), Institutions and their role in conservation; Traditional knowledge, Traditions & cultures, Women in conservation Traditional Societies (e.g. bedas, kadu kurubas, tribble peoples). Role of NGOs in conservation; International NGOs; UNEP, GEF, WCS, Bird Life International Important NGOs in India & their contributions , WWF, ATREE, BNHS, WTI, Kalpavriksha etc.	14

	<p>Important NGO movements, Chipko movement, Narmada Bachavo Aandholan, Pani Panchayats, Seed Movement etc. –</p> <p>Wildlife and legislation: Constitutional provisions, National and International guidelines and protocols. Wildlife and forest protection acts.</p>	
<p><b>References (indicative)</b></p> <ol style="list-style-type: none"> <li>1. Aaron, N.M., Wildlife ecology, W.H. Freeman Co. San Francisco, U.S.A., 1973.21</li> <li>2. Ali, S and S.D. Ripley. 1969. The Handbook of Birds of India and Pakistan. Oxford University Press – New Delhi</li> <li>3. Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly, Wildlife Ecology, Conservation and Management, Blackwell Publishing, U.S.A., 2006.</li> <li>4. Apte, Deepak, The Book of Indian Shells, Oxford University Press, Mumbai. 2006.</li> <li>5. Arora B. M. , Editor, Indian Wildlife Yearbook, AIZ &amp; WV, Bareilly and Central Zoo Authority, New Delhi , 2002</li> <li>6. Brander, A.A, Wild Animals in Central India, Natraj Publisher, Dehradun.</li> <li>7. FAO. 1992. Conservation and Development of Tropical Forest Resources, FAO Publications, Rome.</li> <li>8. Frankal, Otto H., Anthony, A., Brown, D. and Burdon, Jeremy J., The conservation of plant biodiversity. Cambridge University Press, 1995.</li> <li>9. Giles, R.H Jr. 1984, Wildlife Management Techniques, 3rd ed. The Wildlife Society, Washington, D.C. Nataraj Publishers, Dehra Dun, India</li> <li>10. Gopal, Rajesh, Fundamentals of Wildlife Management, Justice Home, Allahabad, India. 1992</li> <li>11. Hosetti, B.B 2002. Wetlands Conservation and Management. Pointer Publishers, Jaipur, India</li> <li>12. Hosetti, B.B. 2003. Wetlands conservation and management, Pointer publishers, Jaipur, India.</li> <li>13. Hosetti, B.B. Concepts in Wildlife Management, Daya Publishing House, Delhi. 1997.</li> <li>14. Katwal/Banerjee, Biodiversity conservation in managed and protected Areas, Agrobios, India, 2002.</li> <li>15. Negi, S.S. 2002. Hand book of National Parks, Wildlife Sanctuaries and Biosphere reserves in India. Indus Publ., New Delhi.</li> <li>16. Negi, S.S., Biodiversity and its conservation in India, Indus Publishing Co., New Delhi. 1993.</li> <li>17. Singh, S.K. Text Book of Wildlife Management. IBDC, Lucknow. 2005</li> </ol>		

**GEC1: B) Entrepreneurial Zoology**

<b>Course Title:</b> B) Entrepreneurial Zoology	<b>Course code:</b> 24ZOO3G1BL
<b>Total Contact Hours:</b> 28 (02 L-0-0)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (COs):****At the end of the course, students will be able to:**

1. Develop knowledge of decision making on appropriate technique based on the environment and conditions.
2. Develop entrepreneur qualities especially in selecting the right business at the right environment.
3. Develop small scale business based on the available sources.

<b>Unit</b>	<b>Description</b>	<b>Hrs</b>
1	<p>Sericulture: History and present status - Sericulture in India - Types of silkworms and distribution.</p> <p>Silkworm rearing technology, Food plant cultivation, seed production, reeling, re-reeling, twisting, doubling and weaving.</p> <p>Diseases and pests of Silkworm: Protozoan, Viral, Bacterial and fungal diseases.</p> <p>Silkworm pests: —Indian Uzifly and Dermistid beetles.</p>	14
2	<p>Apiculture: Introduction and present status. Distribution and behavior of Apis dorsata, Apis cerana indica.</p> <p>Structure &amp; Morphology, Life cycle, colony organization, division of labour and communication.</p> <p>Beekeeping equipments, beekeeping and its products.</p> <p>Diseases and pests of Bees: Bacterial, fungal and viral diseases.</p> <p>Bee pests: Mites, beetles and moths.</p> <p>Management of pests and diseases.</p> <p>Oyster culture: History and present status. Seed production of oysters and collection methods.</p> <p>Habitat management – Preparation of nurseries, Feed and nutrition, Factors affecting nurseries and development.</p> <p>Edible oysters and Pear oysters.</p> <p>Predators, Diseases and Environmental factors that affect oysters.</p>	14

**References**

1. Eikichi, H. (1999). Silkworm Breeding (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
2. Ganga, G. (2003). Comprehensive Sericulture Vol.-II: Silkworm Rearing and Silk Reeling.
3. Hisao Aruga. (1994). Principles of Sericulture (Translated from Japanese). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

**GEC1: C) Hormones and Diseases**

<b>Course Title:</b> C) Hormones and Diseases	<b>Course code:</b> 24ZOO3G1CL
<b>Total Contact Hours:</b> 28 (02 L-0-0)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (COs):****At the end of the course, students will be able to:**

1. Describe the major clinical disorders associated with the adrenal gland (Addison's disease, Cushing's disease, Cushing's syndrome, hyperaldosteronism, congenital adrenal hyperplasia).
2. Explain signs, symptoms and investigations related to endocrine disorders and explain the scientific bases for common disease presentations by Integrating basic sciences with clinical sciences of the endocrine system.
3. Describe the anatomical and histological structure, development, and function of the different organs of the endocrine system.
4. Elucidate the various hormones produced and regulated by the endocrine system.
5. Knowledge about the diseases affecting hypothalamus, pituitary, parathyroid and thyroid.

<b>Unit</b>	<b>Description</b>	<b>Hrs</b>
1	Endocrine glands and hormones <b>Pituitary gland:</b> General organization and hormones Diseases: dwarfism, gigantism, acromegaly, diabetes insipidus <b>Thyroid:</b> General organization and hormones Diseases: goiter, myxoedema, cretinism <b>Parathyroid gland:</b> General organization and hormones Diseases: osteoporosis and tetany <b>Islets of Langerhans:</b> General organization and hormones Disease: diabetes mellitus (type I and type II)	14
2	<b>Adrenal gland:</b> General organization and hormones Diseases: Addison's disease, Cushing's syndrome <b>Testis:</b> General organization and hormones Male infertility Cryptorchidism <b>Ovary:</b> General organization and hormones Diseases: polycystic ovarian disease, hirsutism, and hyperandrogenism.	14

	Hormones and cancer Hormones and stress Obesity, and eating disorders Melatonin, sleep disorders, and jet lag	
<b>References</b> <ol style="list-style-type: none"><li>1. Hadley, M.C.: Endocrinology, Prentice Hall, International Edition, 2000.</li><li>2. Wilson and Foster, Williams Text Book of Endocrinology 10th edition, W.B. Saunders Company Philadelphia, 2005.</li></ol>		

**SEC3: Research Methodology**

<b>Course Title:</b> Research Methodology	<b>Course code:</b> 24ZOO3S3LP
<b>Total Contact Hours:</b> 28 (01 L-0-02P)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (COs):****At the end of the course, students will be able to:**

1. Understand the concept of research and different types of research in the context of biology
2. Analyze the ethical aspects of research
3. Evaluate the different methods of scientific writing and reporting
4. Execute the research problem

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<b>Basic Concept of Research:</b> Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.	14
2	<b>Research Design and Methods:</b> Basic Principles, need of research design, features of good design, important concepts relating to research design. Developing a research plan: Exploration, Description, Diagnosis, Experimentation. <b>Ethics and Art of Scientific Writing:</b> Authors, acknowledgements, reproducibility, plagiarism, Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Power-point presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.	14

**References (indicative)**

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S. E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.
4. Kothari, C. R. (1980). Research Methodology: Research and techniques, New Delhi: New Age International Publishers.
5. Kumar, R. (2011). Research Methodology: a step-by-step guide for beginners (3rd edition). London, UK: TJ International Ltd, Padstow, Cornwall.

**DSC9P7: Reproductive Biology and Artificial Organs Lab**

<b>Course Title:</b> Reproductive Biology and Artificial Organs Lab	<b>Course code:</b> 24ZOO3C9P
<b>Total Contact Hours:</b> 56 (0-0-4P/week)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 4 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Perform vaginal smear technique to identify the phases of oestrous cycle.
2. Illustrate the reproductive dysfunctions.
3. Justify the artificial control of reproduction.
4. Explain the male and female reproductive systems and sexual dimorphic characteristics.
5. Identify the histological slides of reproductive organ/tissues
6. Comment on merits and demerits of contraceptive devices/methods
7. Illustrate the technique of gonadectomy.
8. Distinguish the male and female anatomical features of reproductive system in mammals.

SL No	List of experiments	Hours
1	Study of mammalian reproductive system: ovary and female accessory reproductive organs, and testis and male accessory reproductive organs in rat.	
	Histology of testis and ovary of different age groups of rats to understand the sequence of events related to spermatogenesis and folliculogenesis and ageing effect.	
2	Histology of accessory sex organs	
3	Comparative account of Ovary and Testis in non-mammalian vertebrates – T.S. of fish, amphibia, reptiles and birds.	
4	Pathology of reproductive system: Males- Cryptorchid testis, prostate cancer; Females- Polycystic ovary, endometriosis.	
5	Vaginal smear preparation to study oestrous cycle.	
6	Study of sperm morphology, abnormalities and sperm count in rat	
7	Surgical sterilization of male and female rats.	
8	Pseudopregnancy and delayed implantation in adult lactating rats.	

7	Mounting spermatozoa – Grosshopper/Frog/Chick/Rat	
8	Demonstration class : Pregnancy testing by using HCG kit.	
9	Identification of types of placenta sections	
10	Study of contraceptive devices	

**References:**

1. Knobil, E and Neill, J.D. (Eds). The Physiology of Reproduction II. Vol I and II. Raven Press Ltd, 1994.
2. Mandal, A. Handbook of Neuroendocrinology. EMKAY Publications, 1994.
3. Nelson, R.J. An Introduction to Behavioural Endocrinology. Sinauer Associates Inc, 1995.
4. Turner, CD and Bagnara, J.T. General and Comparative Endocrinology, 1998.
5. Williams, RM. Textbook of Endocrinology. W.B. Saunders.
6. Martin, C.R Endocrine Physiology. Oxford University Press.
7. Saidapur S. K. (Ed). Reproductive Cycles of Indian Vertebrates. Allied Publishers Ltd. New Delhi, 1989.
8. 'Tissue Engineering and Artificial Organs' By Joseph D. Bronzino.
9. "Artificial Organs" by Gerald E.Miller Morgan & Claypool Publisher.

**DSC10P8: Environmental Biology Lab**

<b>Course Title:</b> Environmental Biology Lab	<b>Course code:</b> 24ZOO3C10P
<b>Total Contact Hours:</b> 56 (0-0-4P/week)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 4 h
<b>Summative Assessment Marks:</b> 30	

**Course Outcomes (CO's):****At the end of the course, students will be able to:**

1. Apply information learned through readings and other media posted with the learning management system (LMS)
2. Comprehend the interdisciplinary (e.g. agricultural science, biology, chemistry, ecology, economics, geology, history, policy, etc.) concepts integral to environmental science
3. Analyze current environmental issues and evaluate potential solutions
4. Relate the features of human populations to different types of environmental degradation
5. Assess the costs/benefits of conservation vs. remediation or technological solutions.
6. Recognize the impact of globalization on the environment
7. Recognize the ecological footprints left by different peoples of the Earth
8. Work effectively in a group to teach select environmental concepts to elementary children through the Experiential Environmental Education (E3) project.

<b>SL No</b>	<b>List of experiments</b>	<b>Hours</b>
1	Water quality analysis	
2	Estimation of density and relative abundance of species using quadrats and plotless methods.	
3	Estimation of primary productivity.	
4	Ecological adaptations of the Plant and animal species in the hydrophytes, mesophytes and xerophytes.	
5	Collection of fauna from wetland and diversity analysis	
6	Air quality assessment techniques	
7	Estimation of species diversity: introduction to indices	
8	Data analysis related to Environmental issues	
9	Estimate/ Analyse the impact of Urbanization	
10	Problems associated with urbanization	

11	Environmental Impact assessment	
12	Water quality assessment techniques	
13	Water treatment facility or ecological restoration site	
14	Study on environmental problem of your locality and suggest remedy	
15	Field trips to locations illustrating urbanization issues, such as a recycling center	
16	Field visit to forest patch – data collection and report preparation	
17	Field visit to wetland – data collection and report preparation	
18	Field visit coast - data collection and report preparation	

**References:**

1. EIA – A Biography Clark, B. D., Bissel, B. D. and Watheam, P. School of Forestry and Environment, SHIATSDeemed University, Allahabad.
2. Environmental Impact Assessment Canter, L. W. Graw, Mc, , Hill Publication, New York.

**CBCS Question Paper Pattern for M.Sc. Zoology Semester End Examination with  
Effect from the AY 2024-25**

**Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)**

**Paper Code:**

**Time: 3 Hours**

**Note: Answer any FIVE of the following, each question carries equal marks Question No.1 is Compulsory.**

**Paper Title:**

**Max. Marks: 70**

Q1.	A	7 Marks
	B	7 Marks
Q2.		14 Marks
Q3.		14 Marks
Q4.		14 Marks
Q5.		14 Marks
Q6		14 Marks
Q7		14 Marks
Q8	A	7 Marks
	B	7 Marks

**Note: Questions No.1 to 8, shall be covered from each units with equal/proportionate weightage**

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**Skill Enhancement Courses (SECs)**

**Paper Code:**

**Time: 1 Hours**

There shall be Theory examination of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.

**Paper Title:**

**Max. Marks: 30**

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## **General Elective Course**

Paper Code:

Time: 1 hr.

There shall be theory examination

I containing five compulsory questions of one mark each.

II Answer any five questions of two marks each with two choice (total 7 questions)

III. Answer any three questions of five marks each with two choice (Total 5 questions)

Paper Title

Marks: 30

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**Students shall undertake compulsory study tour covering various research institutes, industries of relevance and natural biomes with an emphasis on biodiversity animal husbandry etc. the duration of the tour shall be about 10 days. The study tour shall be undertaken during III semester. And submission of tour report is compulsaory and five marks will be allotted for the same.**

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### **Question Paper Pattern for Subjects with Tutorial**

**For the subjects with Tutorial component, there is no Semester-End Examination (SEE) to the component C3. The liberty of assessment of C3 is with the concerned faculty. The faculty must present innovative method of evaluation of component C3 before the respective BoS for approval and the same must be submitted to the Registrar and Registrar(Evaluation) before the commencement of the academic year.**

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**VIJAYANAGARA SRI KRISHNADEVARAYA UNIVERSITY  
JNANASAGARA CAMPUS, BALLARI-583105**

**Department of Studies in Zoology**

**SYLLABUS**

**Master of Science  
(IV Semester)**

**With effect from:  
2024-25**

**Distribution of Courses/Papers in Postgraduate Programme IV Semester as per Choice Based Credit System (CBCS) Proposed for PG Program in Zoology**

**IV-SEMESTER**

Semester No.	Category	Subject code	Title of the Paper	Marks			Teaching hours/week			Credit	Duration of exams (Hrs)
				IA	SEE	Total	L	T	P		
<b>FOURTH</b>	DSC11	24ZOO4C11L	Biodiversity and Conservation	30	70	100	4	-	-	4	3
	DSC12	24ZOO4C12L	Toxicology	30	70	100	4	-	-	4	3
	DSE3	24ZOO4E3AL	A) Agricultural Zoology and Entomology	30	70	100	4	-	-	4	3
		24ZOO4E3BL	B) Applied Zoology								
		24ZOO4E3CL	C) Animal Biotechnology								
	DSE4	24ZOO4E4AL	A) Genetic Engineering	30	70	100	4	-	-	4	3
		24ZOO4E4BL	B) Histology and Histotechniques								
		24ZOO4E4CL	C) Livestock Management and Animal Husbandry								
	GEC2	24ZOO4G2AL	A) Global Environmental Issues	20	30	50	2	-	-	2	2
		24ZOO4G2BL	B) Public Health, Hygiene and diseases								
24ZOO4G2CL		C) Human reproductive health issues and Sex Education									
DSC11L9	24ZOO4C11P	Biodiversity and Conservation Lab	20	30	50	-	-	4	2	4	
Project	24ZOO4C1R	Research Project	30	70	100		-	8	4	4	
<b>Total Marks for IV Semester</b>						<b>600</b>				<b>24</b>	

**Department Name: Zoology**  
**Semester-IV**

**DSC11: Biodiversity and Conservation**

<b>Course Title:</b> Biodiversity and Conservation	<b>Course code:</b> 24ZOO4C11L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 hr
<b>Summative Assessment Marks:</b> 70	

**Course Outcomes (CO's):**

**At the end of the course, students will be able to:**

1. Understand the basics of science of biodiversity in an ecological context.
2. Learn the tools and techniques relevant to monitoring of biological diversity
3. Design a field based project with rationale and appropriate methodology.
4. Interpret basics of science of biodiversity conservation covered in Modules
5. Study and understand the animals around us and their significance.
6. Know the importance of understanding the legal context for conservation management.
7. Know the main elements of the legal framework that underpins biodiversity conservation nationally and internationally.
8. Understand the meaning of the term “Stakeholders” and ‘governance’ and the relevance of both to biodiversity conservation.

<b>Unit</b>	<b>Description</b>	<b>Hours</b>
1	<p><b>Biodiversity:</b> Concepts, Definition.            Values of biodiversity: Consumptive use and Productive use; Social, Ethical, Aesthetic, Option &amp; Environment service values.            Biodiversity at global, national and local levels.            Hot spots of biodiversity; India as a mega diversity nation.            Endemism and endemic species.            Genetic diversity: Nature and origin of genetic variations; Measurement of genetic diversity.            Species diversity: History and origin of species diversity; Species diversity indices; Measures of diversity – Alpha, Beta &amp; Gamma diversity.            Ecosystem diversity: Classification and nature of ecosystems (in brief); Ecosystem diversity of India (in brief)</p>	14
2	<p><b>Agro- biodiversity:</b> Origin and evolution of cultivated species diversity; Vavilovian centers ; Diversity in domesticated animal species.</p>	14

	<p>Threats to biodiversity: Deforestation &amp; habitat destruction, Hunting &amp; Overexploitation; Introduction of exotic species, Pollution.</p> <p>Endangered, Vulnerable, Rare and Threatened species.</p> <p>Conservation of Biodiversity: Objectives and action plans; Strategies – In-situ and Ex-situ conservation; Peoples movement, Role of educational Institutions and NGO's,</p> <p>Biodiversity Awareness programmes</p>	
3	<p><b>Biodiversity and Biotechnology:</b> Role of Biotechnology in Assessment of biodiversity and bioresources; Biodiversity conservation; Utilization of Biodiversity / Bioresources. GMO's and their impact on biodiversity.</p> <p>Biodiversity legislation: Legal aspects with special reference to India; CITES; Trade related Intellectual Property Rights.</p>	14
4	<p><b>Biodiversity conventions:</b> Earth Summit and other conventions; Convention on Biological Diversity.</p> <p>Biodiversity Management: Organizations associated with biodiversity management– IUCN, UNEP, UNESCO, WWF, FAD,WCMC –their role and contributions.</p> <p>Bioprospecting; Biopiracy; Biosafety.</p> <p>Future strategies for Biodiversity Conservation in India.</p>	14
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Dasmann. F Raymond. Wildlife Biology. Wiley Eastern Ltd. India.1982.</li> <li>2. Encyclopedia of Nature and Science. Vols 1-18. Bay Books Pvt. Ltd. Sydney, 1974.</li> <li>3. Burnie. D. (Ed). Animal: the Definitive Visual Guide to the Worlds Wildlife. D.K. Publications, 2001.</li> </ol>		

## DSC12: Toxicology

<b>Course Title:</b> Toxicology	<b>Course code:</b> 24ZOO4C12L
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

### Course Outcomes (CO's):

#### At the end of the course, students will be able to:

1. Learn basic principles of signaling pathways and mechanisms of cell death
2. Understand mechanisms of systemic and organ toxicity induced by xenobiotics; and learn how to analyze and interpret complex data sets in toxicological research and deliver a scientific presentation.
3. To acquire knowledge on principles of toxicology and governing toxic responses to chemical exposures.
4. To learn the presence of toxic substances in the environment and poisonous substances of plant and animal origin
5. Introduce students the various procedures in the field of toxicology
6. Teach students how toxicants interact with target organs.
7. To learn the risk assessment of toxic substances and their applications in various fields.

Unit	Description	Hours
1	<b>Fundamentals of Toxicology:</b> Introduction to general toxicology, Definition, history, scope and importance of toxicology. Basic concept of toxicology: Toxicants and toxicity. Factors affecting toxicity: species and strains, age, sex, nutritional status, hormone, environmental factors. Dose; Effect and response; dose response relationships; exposure routes. Specialized areas, Types of toxicants, Toxicokinetics: Absorption, distribution, metabolism, and excretion (ADME) of toxic substances.	14
2	<b>Toxicologic testing methods:</b> Acute and chronic toxicity tests, LD50 and LC50 assessment. Teratogenicity testing. Reproductive toxicology– Effect of xenobiotics on male and female reproductive organs/cells in mammals. Organ/tissues specific toxicity. Toxicity of metals (Lead, Mercury, Arsenic, Cadmium). Pesticide toxicity- Acute and Chronic effects of organophosphate, Organo-chlorine and Carbamate insecticides, Natural toxins- Import microbial, plant and animal toxins. NOEL/NOAEL.	14
3	<b>Applied Toxicology:</b> Regulatory toxicology, Regulatory agencies, Regulation of Industrial	14

	<p>chemicals in USA and EU, Regulation of pesticides, regulation of pharmaceuticals, regulation of food additives.</p> <p>Cosmetic toxicology- Toxicity of shampoos, conditioners, bleachers, dyes, allergic and respiratory disorders.</p> <p>Wildlife toxicology- Toxicology of chemicals in birds and mammals, Integrated approach to wildlife toxicology.</p> <p>Forensic toxicology- Specimen sample collection, types of testing, detection of poisons, applications of forensic toxicology.</p>	
4	<p><b>Systemic Toxicology and Toxicants of public health</b></p> <p>Basics of organ toxicity: Target organs, organ selectivity and specificity.</p> <p>Hepatotoxicity: susceptibility of the liver; Types of liver injury and biochemical mechanism.</p> <p>Pulmonary toxicity: Lung injury, systematic lung toxins, lung pathology.</p> <p>Renal toxicity: susceptibility of the kidney to toxicants; Chemical induced renal injury.</p> <p>Neuro toxicity: Effect of toxic agents on neurons, ion channel neurotoxins; Lesions of neural tissue.</p> <p>Toxic chemicals and their effects: pesticides; heavy metals; fertilizers; food additives. Radioactive substances; automobile emissions.</p>	14
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. Environmental Biology and Toxicology. P. D. Sharma. Rasthogi Publications.</li> <li>2. Text Book of Pharmacology &amp; Toxicology by Goodman &amp; Gillman</li> <li>3. Williams, P.L.; James, R. C. Roberts, S.M. (2003) Principles of Toxicology: Environmental and Industrial Applications, John Wiley &amp; Sons, Inc.</li> <li>4. Klaassen, C. (2007) Casarett and Doull's Toxicology The basic science of poisons – McGraw-Hill.</li> <li>5. Duffs, J. and Worth, H. (2006) Fundamental Toxicology, RSC Publishing.</li> <li>6. Phillip L. Williams, 2000. Principles of Toxicology, JOHN WILEY &amp; SONS, INC.</li> </ol>		

### DSE 3: A) Agricultural Zoology and Entomology

<b>Course Title:</b> A) Agricultural Zoology and Entomology	<b>Course code:</b> 24ZOO4E3AL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

#### Course Outcomes (CO's):

##### At the end of the course, students will be able to:

1. Differentiate different types of metamorphosis, larva and pupa found in insects.
2. Learn about fertilization, development of oocyte, blastoderm formation blastokinesis and organogenesis.
3. Gain knowledge about the different types of reproduction in insects, hatching and shedding of embryonic cuticle.
4. Interpret the various methods of pest control by understanding the lifecycle of microbes, insects and other animals.

Unit	Description	Hours
1	Principles and practices of pest control. Methods of pest control- Chemical Biological, Microbiological, Microbial, Integrated control. Organochlorine, Insecticides, Organophorous insecticides, Carbamates, Acaricides, Nematicides, Rodenticides, Molluscicides and Botanical pesticides. Pheromonal and Hormonal control. Chemosterilants and genetic control.	14
2	Biology and control of following insect pests of agricultural importance: Termites, Rice weevils, Castor hairy caterpillar, codling moth, mango mealy bug, Cotton white fly, citrus psylla and cabbage Caterpillar. Biology and control of some important Phytoparastic nematodes; Anguina, Xiphinemasp & Heterodera sp.	14
3	External morphology of the insect's body i.e. head, thorax and abdomen, their appendages and function. Insect integument and its derivatives, Structure of insect cuticle and its function Head: origin, type, structure, types of mouth parts and antennae Thorax: Areas and sutures of tergum, sternum and pleuron, pterothorax; wings: structure and modification, wing venation, wing coupling apparatus; Legs: structure and modifications. Abdomen: Segmentation and appendages, genitalia and their modifications Stridulatory organs and sound producing organs.	14
4	Glandular system: Salivary glands, poison glands, wax glands, coxal glands	14

	<p>and scent glands.</p> <p>Sensory system: mechanical stimuli, sense of vision, organs of smell, tastes and hearing. Circulatory system: heart, haemolymph and circulation, phosphorescence. Respiratory system: Spiracles and their general structure, trachea and tracheoles. Digestive canal and digestion in insects.</p> <p>Types of metamorphosis. Development of Imago :- fertilization, development of oocyte, cleavage and blastoderm formation, germ band formation, blastokinesis. Organogenesis. Viviparity, polyembryony, parthenogenesis paedogenesis. Hatching and shedding of embryonic cuticle, number and duration of instars, types of larva, pupa and its significance.</p>	
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**References:**

1. Awasti V.B. 2009 Introduction to general entomology 3rd Ed. Scientific publication (India), Jodhpur.
2. Rajendra singh. 2007. Elements of Entomology. Published by Rakeshkumar. Rastogi and Rastogi Publications. Gangotri, Shivaji Road. Meerut.
3. Trigunayat M.M. 2009, A Manual of practical entomology, scientific publishers, Jodhpur, India.
4. David BV & Ananthkrishnan TN. 2004. General and Applied Entomology. Tata-McGraw Hill, New Delhi.
5. Duntson PA. 2004. The Insects: Structure, Function and Biodiversity. Kalyani Publ., New Delhi.
6. Evans JW. 2004. Outlines of Agricultural Entomology. Asiatic Publ., New Delhi.
7. Atwal, A. S. and Dhaliwal G.S.1997.Agriculture pests of South Asia and their management. Kalyani Publishers New Delhi.

### DSE 3: B) Applied Zoology

<b>Course Title:</b> B) Applied Zoology	<b>Course code:</b> 24ZOO4E3BL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

#### Course Outcomes (CO's):

##### At the end of the course, students will be able to:

1. Understand the basic concept of pearl culture.
2. Provide the elementary knowledge regarding the Anatomical and Physiological aspects of fresh water oysters.
3. Familiarize with the various types of implantation methods and pearl culture surgery techniques.
4. Gain knowledge on production of pearl and its marketing for economic gain.
5. Understand the scope and importance of piggery.
6. Comprehend the various technical and managerial aspects involved in piggery.
7. Identify the support available from various government agencies for piggery.
8. Identify Breeds and hybrids of rabbit
9. Learn management of pregnant and lactating rabbits.

Unit	Description	Hours
1	History, scope and importance of apiculture, Classification of honeybees with special reference to Indian species, Morphology and structural adaptations of honey bees, Social organization, division of labour, comb building, communication in honeybees. Beekeeping- rearing equipments, honey bee species employed in rearing, queen rearing, Flora and seasonal management. Honey bee diseases, pests and predators and their control.	14
2	Global silk production, quality and quantity of silk produced in India, economics of silk production, foreign exchange. Features of Saturnidae and Bombycidae. Races of mulberry silkworms, classification based on voltinism, moulting and geographic origin. Structure and functions of Silk glands. Seed cocoons, preservation, egg production, incubation, artificial hatching, seed organisation and seed area. Protozoan, Fungal, Viral and Bacterial diseases and their control measures.	14
3	Introduction to pearl culture. Global and national status of pearl culture, History of pearl culture, Significance of pearl culture. Types of oysters Fresh water oysters, Internal anatomy: Alimentary canal and associated structure, Food and feeding habit of Oyster. Pearl oyster Surgery,	14

	Selection of Oyster, Half round Pearl culture. Caring of pearl oyster. Harvesting of Pearls. Sorting of Pearl. Marketing and economics concerned with Pearl Culture. Generation of funds.	
4	<p>Importance and scope for Piggery Farming, selection of land and construction of shed and its maintenance. Various breeds of pigs, Feeding of Pigs, Breeding practices, Care and Management of new born piglets. General Management of Piggery unit, Common Diseases in pigs and their control. Economics of a Piggery unit, Waste management in piggery.</p> <p>Scope of rabbit farming, breeds and their distributions in India. Selection, care and management of breeding stock for commercial purpose. Identification, care and management of rabbits. Care of new born, growing stock. Breeding and selection techniques for optimal production of rabbit. Feeds and feed production for rabbit. Hygienic care and Housing for rabbit production, Rabbit meat production. Disposal and utilization of fur and wool and recycling of waste by products.</p>	14

**References:**

1. Mishra R C (1999). Perspectives in Indian Apiculture. Allied Scientific Publishers, Bikaner, India. Srivastava (1979). Applied Entamology. Vol. II.
2. Singh S (1962). Beekeeping in India. ICAR, New Delhi, India. Snodgrass R E (1956). Anatomy of the Honeybee. Cornell University Press, Ithaca, New York.
3. Winston M (1984). The Biology of the Honeybee. Harvard Uni Press, London, U K
4. Shukla G S and Upadhyay V B (2007). Economic Zoology, 4th revised edn. Rastogi publications, Meerut, india.
5. Pillay TVR & Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
6. Introduction to Fishes. Silver Line 3. Srivastava C.B.L. (2014). Fishery Science and Indian Fisheries.
7. Haws Maria (March2002) The basics of pearl farming: a Layman's manual: (U.S.A). CTSA publications.
8. Le Jia Li (2014)New technologies to promote freshwater pearl culture (China) Ocean Press publications.
9. William F Roth (2013) Rabbit Culture and Standard; A Complete and Official Standard of All the Rabbits. Nabu Press; Primary Source ed. Edition.126 pages.
10. Nityan and Pathak, Usha Rani Mehra, Kishore Kumar Baruah (2014).Rabbit Production

### DSE 3: C) Animal Biotechnology

<b>Course Title:</b> C) Animal Biotechnology	<b>Course code:</b> 24ZOO4E3CL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

#### Course Outcomes (CO's):

##### At the end of the course, students will be able to:

1. Understand the animal cell culture, animal diseases and its diagnosis
2. Gain the knowledge for therapy of animal infections
3. Know the concepts of micromanipulation technology and transgenic animal technology
4. Use the knowledge gained in this section to apply in the field of clinical research
5. Use various techniques involved in making of transgenic animals
6. Integrate assisted reproductive biotechnology techniques in livestock improvement.
7. Utilize animal production technologies for sustainable agriculture and food security

Unit	Description	Hours
1	<b>Introduction to basic tissue culture techniques;</b> chemically defined and serum free media; animal cell cultures, their maintenance and preservation; various types of cultures suspension cultures, organ cultures. Bacterial and viral diseases in animals; monoclonal antibodies and their use in diagnosis; molecular diagnostic techniques like PCR, in-situ hybridization; northern and southern blotting.	14
2	<b>Concepts of transgenic animal technology;</b> strategies for the production of transgenic animals and their importance in biotechnology; stem cell cultures in the production of transgenic animals. Identification and transfer of gene influencing better production and disease resistance.	14
3	<b>Gene transfer methods in animals:</b> Microinjection, Retrovirus mediated gene delivery, Embryonic stem cell mediated gene transfer; Knockout model systems & their utility; Somatic cell nuclear transfer cloning; In Vitro Fertilization, Embryo production, preservation and transfer; Sperm and embryo sexing; Intracytoplasmic sperm injection (ICSI); Cryopreservation and gamete banking.	14
4	<b>Gene therapy, mapping of human genome.</b> RFLP and applications. DNA finger printing and Forensic Science. Molecular diagnosis of Genetic disorders. Valuable products from cell culture, vaccines, recombinant proteins, monoclonal antibodies, hybrid antibodies, hybrid antibodies, interferon, insulin, growth hormone.	14

**References:**

1. Ranga M.M. Animal Biotechnology. Agrobios India Limited, 2002
2. Freshney RI (1992) Animal cell culture: a practical approach, Oxford University Press
3. Singh B, Gautam SK (2013) Text Book of Animal Biotechnology, TERI
4. Singh B, Mal G, Gautam SK, Mukesh M (2019) Advances in Animal Biotechnology, Springer
5. Butler M (2003) Animal Cell Culture and Technology, Taylor & Francis
6. Freshney, E. D. 2000. Animal Cell Culture: A practical approach. John Wiley Pub., New York.
7. Mather, J.P. and Barnes, D. (Eds.). 1998. Animal Cell Culture Methods (Methods in Cell Biology.VOL. 57). Academic Press, London.
8. Animal cell culture – A practical approach Ed. By John R.W. Masters (IRL Press)

## DSE 4: A) Genetic Engineering

<b>Course Title:</b> A) Genetic Engineering	<b>Course code:</b> 24ZOO4E4AL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

### Course Outcomes (CO's):

At the end of the course, students will be able to:

1. Gain practical skill on handling biological molecules
2. Apply knowledge to develop new rDNA with suitable markers
3. Develop a skill in operation of instruments
4. Give a probable solution to social problems related to health and disease
5. Perform experiments on extraction of DNA from unknown samples.

Unit	Description	Hours
1	<b>Principles of Genetic Engineering:</b> Nucleic acids and their isolation techniques, Principles of isolation, purification and quantification. DNA modifying enzymes: RENS, nucleases, polymerases, ligases, kinases and phosphatases. Cloning vectors: Plasmids, phages, cosmids and artificial chromosomes. Cloning hosts: <i>Escherichia coli</i> , <i>Saccharomyces</i> , animal cells.	14
2	<b>Gene transfer:</b> Physical and vector mediated cloning methods, directional and TA cloning methods. Construction and screening of <i>DNA libraries</i> : genomic library, cDNA library and expression libraries. <i>PCR</i> : Principles and methodology. Types: RT-PCR, AFLP, RFLP, inverse PCR and real time PCR and applications. Down-regulation of gene expression using siRNA technology.	14
3	<b>DNA sequencing:</b> Maxam and Gilbert's method and Sanger's method and their applications. Automated sequencing technique and capillary gel electrophoresis, Next generation sequencing methods (NSG). Isolation and characterization of genes from genomic <i>DNA libraries</i> . New strategies for gene knockout.	14
4	<b>Genetic engineering techniques:</b> Gel electrophoresis using agarose and polyacrylamides. <i>Blotting</i> of macromolecules: probe selection and labeling. <i>Hybridization</i> : gene screening-colony, plaque, dot, blotting techniques. Antibody screening; oligonucleotide synthesis; promoter characterization, <i>Transgenic animals</i> : <i>Drosophila</i> and mouse.	14

**References:**

1. Baker KH; Bioremediation. McGraw Hill, New York
2. Barnum SR; Biotechnology; Indian edition; Vikas pub.; 1998
3. Benjamin A. Pierce: genetics – a conceptual approach
4. Biotechnology in Environmental Management: edited by G.R. Pathade and P.K. Goel. Jaipur, ABD, 2004
5. Brown, T. A. (2015): Gene Cloning: An introduction. 7th edition. Chapman and Hall, London
6. Daniel L. Hartl & Elizabeth W. Jones: Genetics – analysis of Genes & Genomes
7. Glick, B. R. and Pasternak, J. J. (1994): Molecular Biotechnology: Principles and applications of recombinant DNA. ASM Press, Washington D.C.
8. Kreuzer, H. and A. Massey. (2001): Recombinant DNA and Biotechnology. ASM Press, Washington DC.
9. Pepler and Periman: Microbial technology; 2nd Ed; Academic press; 2004
10. Primrose, S. B., and R. M. Twyman. (2006): Principles of gene manipulation and Genomics, Blackwell Publishing MA. USA.
11. William Wu, Michael Welsh, Peter Kaufman, Helen Zhang (2004): Gene Biotechnology II edition, CRC press, LLC, USA

#### DSE 4: B) Histology and Histotechniques

<b>Course Title:</b> B) Histology and Histotechniques	<b>Course code:</b> 24ZOO4E4BL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

#### Course Outcomes (CO's):

##### At the end of the course, students will be able to:

1. Isolate and distinguish different tissues from an organ sample
2. Recognise the structure of various tissues in animal organism
3. Perform histological procedures for observation
4. Classify different tools used in histological techniques
5. Analyse histology of various organs of human body.

Unit	Description	Hours
1	<b>Microscopy:</b> Principles and resolution of conventional microscopes, light microscopes, phase contrast, fluorescent, and electron microscopes. Tissue processing. Cell membranes and transport across membranes, cell junctions. <i>Epithelia:</i> Classification, structure, location and functions. Projections from cell surface. Components of general <i>connective tissue</i> . <i>Cartilage:</i> general structure, types, distribution and functions.	14
2	<b>Bone:</b> structure, elements of bone tissue, types of bone, formation and growth & development of bone. <i>Muscular tissue:</i> structure of different types of muscles, mechanism of contraction of muscles. <i>Lymphatics</i> and lymphoid tissues: Diffuse and dense, cells, capillaries and nodes. The spleen, the thymus, tonsils. <i>Blood:</i> components, hemopoiesis, Mononuclear phagocyte system.	14
3	<b>Nerve tissue:</b> Anatomical classification, structure of nerve components, types of neurons, Neuroglea. <i>Histology</i> of sensory organs: human eye and ear. <i>Hepatobiliary system and pancreas:</i> Histology of liver, duct system and functions. Extrahepatic biliary apparatus. Exocrine pancreas, histology and endocrine pancreas. <i>Oral</i> structures: Pictomicrograph study of teeth, tongue and salivary glands	14
4	<b>Organ histology:</b> T.S. of oesophagus, stomach, duodenum, jejunum, ileum and large intestine. <i>Histotechniques:</i> Outline of methods employed in histology: preparation, fixation and fixatives. Dehydration, clearing and paraffin embedding methods. <i>Microtomy:</i> mechanics, wet and dry sectioning. <i>Staining:</i> substances, techniques and mechanism.	14

#### References:

1. Carleton H.M (1957): Histological techniques for normal and pathological tissues, III edition, Oxford University press.

2. Grerchen L. Humason. Animal tissue techniques. W.H Freeman and Company.
3. K Laxminarayan. Histological techniques, second edition, Bhalani.
4. Kleith Moore, Persaud and Mark Torchia. The developing human: clinically oriented embryology, eleventh edition. Elsevier.
5. Neelam Vasudeva and Sabita Mishra (2014): Inderbir Singh's text book of human physiology, seventh edition, Jaypee brothers' medical publishers pvt.ltd. New Delhi.
6. Piper Treuting, Suzanne Dintzis and Kathleen Montine. Comparative anatomy and histology: a mouse, rat and human atlas. Elsevier.
7. PoSing Leung. The gastrointestinal system: Gastrointestinal, nutritional and hepatobiliary physiology. Springer.
8. Sangita Chouhan and Seema Gupta. Histology: A text and practical book.
9. Stevens and Lowe. Human Histology by James Lowe, Peter Anderson and Susan Anderson. Elsevier.
10. Wojciech P. Histology: a text and atlas correlated with cell and molecular biology. Wolters Kluwer.

## DSE4: C) Livestock Management and Animal Husbandry

<b>Course Title:</b> C) Livestock Management and Animal Husbandry	<b>Course code:</b> 24ZOO4E4CL
<b>Total Contact Hours:</b> 56	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 3 h
<b>Summative Assessment Marks:</b> 70	

### Course Outcomes (CO's):

**At the end of the course, students will be able to:**

1. Gain knowledge on identification of animal husbandry animals
2. Learn management practices in detail
3. Design a concrete animal house model with all prerequisites
4. Perform disease management in the farm
5. Assess the economical products from the animal husbandry.

Unit	Description	Hours
1	<b>History of livestock</b> rearing, Live stock farming zones in India, Common animal husbandry terms. <i>Classification</i> of domestic animals. Ruminants and non-ruminants. Animal husbandry in India – present and future. Body parts of domestic animals, general management practices. <i>Breeds of livestock:</i> Breeds of cattle, buffaloes, sheep, goats and pigs.	14
2	<b>Breeding of farm animals:</b> economic traits of inheritance, selection and culling, breeding systems. <i>Housing:</i> types, planning farm housing, requirements, manure disposal and constructional details of different structures. <i>Nutrition:</i> Composition and preparation of common feed and fodder, hay making, silage making, computation of balanced rations and feeding standard, feeding, breeding, management and economics.	14
3	<b>Livestock production management:</b> livestock production system, Economic considerations in livestock farming, marking, feeding, breeding and prophylactic record keeping. Livestock production in rural development, planning and management of integrated livestock development project in India. <i>Livestock extension:</i> Features, adoption potential, constraints of extension services, low-cost instructional materials. Privatization of extension, rapid and participatory rural appraisals.	14
4	<b>Livestock in natural calamities:</b> common natural calamities, emergencies for livestock during natural disasters, delayed consequences of disasters and feeding during scarcity conditions. <i>Health management:</i> signs of good health, diseases, control, first aid on animal farms. <i>By-products:</i> Leather, hydes, hoof, horn, collagen, fur and other economic products.	14

### References:

1. V.N Goutham: A text book of livestock production and management, Avishkar publisher, Jaipur, ISBN: 978-8179105-528
2. Sastry NSR and Thomas CK: Livestock production and management, Kalyani publishers.
3. GC Banerjee. A text book of animal husbandry, 8th edition. Oxford and IBH Publishing company, New Delhi.
4. P.N. Bhat and MP Yadav. Animal Husbandry: Research, education and development.
5. Lesley A Colby, Megan Nowland and Lucy Kennedy. Clinical laboratory animal medicine, fifth edition. Wiley Blackwell.
6. P. Mathialagan. A textbook of animal husbandry: extension and education. CNS Publishers and Distributors. WB.
7. John Campbell, Douglas and Kren Campbell. Animal Husbandry: biological sciences and production. Medtech, a division of scientific international.

## GEC2: A) Global Environmental Issues

<b>Course Title:</b> A) Global Environmental Issues	<b>Course code:</b> 24ZOO4G2AL
<b>Total Contact Hours:</b> 28 (02 L-0-0)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1 h
<b>Summative Assessment Marks:</b> 30	

### Course Outcomes (COs):

#### At the end of the course, students will be able to:

1. Understand the fundamental issues of environment
2. Analyze different sources of environmental problems and methods of measurement of pollution.
3. Examine economic growth and quality of life.
4. Examine the microbiology of waste water treatment and its various schemes.

Unit	Description	Hours
1	Basic concepts and issues, global environmental problems - ozone depletion, UV-B, greenhouse effect and acid rain due to anthropogenic activities, Fisheries depletion, Eutrophication, their impact and biotechnological approaches for management. Environmental pollution - types of pollution, Air, water and land pollution. sources of pollution, measurement of pollution, fate of pollutants in the environment, Ocean acidification, Bioconcentration, bio/geomagnification. Carbon foot print and Sequestration	14
2	Aerobic decomposition process - activated sludge, oxidation ponds, trickling filter, towers, rotating discs, rotating drums, oxidation ditch. Anaerobic decomposition process - anaerobic filters, up- flow anaerobic sludge blanket reactors. Treatment schemes for sewage from dairy, distillery, tannery, sugar and pharma industries.	14

#### References (indicative)

1. Frances, H. (2012). Global Environmental Issues (2nd edition) Willey-Blackwell
2. Mahesh, R. (2007) Environmental Issues in India: A Reader. Pearson-Longman.

## GEC 2: B) Public Health, Hygiene and diseases

<b>Course Title:</b> B) Public Health, Hygiene and diseases	<b>Course code:</b> 24ZOO4G2BL
<b>Total Contact Hours:</b> 28 (02 L-0-0)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1 h
<b>Summative Assessment Marks:</b> 30	

### Course Outcomes (COs):

#### At the end of the course, students will be able to:

1. Provide knowledge on different health indicators and types of hygiene methods.
2. Impart knowledge on different health care programmes taken up by India
3. Student understand the latest concepts of health such as HIA, EIA, SIA and SEA
4. Understand disaster mitigation strategies
5. Gain awareness on community health and hygiene
6. Enrich knowledge on communicable and non-communicable diseases and their control.

Unit	Description	Hours
1	<p><b>Health Basics of Nutrition</b></p> <p>Health - Determinants of health, Key Health Indicators, Environment health &amp; Public</p> <p>Health Policy &amp; Health Organizations: Health Indicators and National Health Policy of Govt. of India-2017; Functioning of various nutrition and health organizations in India viz., NIN (National Institution of Nutrition), FNB (Food and Nutrition Board), ICMR (Indian Council of Medical Research), IDA (Indian Dietetics Association), WHO-India, UNICEF-India.</p> <p>National Health Mission: National Rural Health Mission (NRHM) Framework, National Urban Health Mission (NUHM) Framework.</p> <p>Women &amp; Child Health Care Schemes: Reproductive, Maternal, Newborn, Child and Adolescent Health (RMNCH+); Janani Shishu Suraksha Karyakaram (JSSK); Rashtriya Bal Swasthya Karyakram (RBSK); India Newborn Action Plan (INAP); Adolescent Health-Rashtriya Kishor Swasthya Karyakram (RKSK).</p> <p>Disaster Management – Containment, Control and Prevention of Epidemics and Pandemics – Acts, Guidelines and Role of Government and Public</p> <p>Nutrition – definition, importance, Good nutrition and mal nutrition; Balanced Diet: Basics of Meal Planning</p> <p>Carbohydrates –functions, dietary sources, effects of deficiency.</p> <p>Macro and micro minerals –functions, effects of deficiency; food sources</p>	14

	of Calcium, Potassium and Sodium; food sources of Iron, Iodine and Zinc. Importance of water– functions, sources, requirement and effects of deficiency.	
3	<p><b>Hygiene</b>  Definition; Personal, Community, Medical and Culinary hygiene; WASH (Water, Sanitation and Hygiene) programme  Rural Community Health: Village health sanitation &amp; Nutritional committee (Roles &amp; Responsibilities); About Accredited Social Health Activist (ASHA); Village Health Nutrition Day, Rogi Kalyan Samitis.  Community &amp; Personal Hygiene: Environmental Sanitation and Sanitation in Public places  Public Awareness through Digital Media - An Introduction to Mobile Apps of Government of India: NHP, Swasth Bharat, No More Tension, Pradhan Mantri Surakshit Mantritva Abhiyan (PM Suman Yojana), My Hospital (Mera aspaatal), India fights Dengue, JSK Helpline, Ayushman Bhava, Arogya Setu, Covid 19AP.</p> <p><b>Diseases</b>  Communicable diseases and their preventive and control measures. Measles, Malaria, Hepatitis, Cholera, Filariasis, HIV /AIDS Corona Virus (Covid-19). Non-Communicable diseases and their preventive measures. Genetic diseases, Cancer, Cardio vascular diseases, Chronic respiratory disease, Diabetes, Epilepsy.  Health Education in India – WHO Programmes – Government and Voluntary Organizations and their health services – Precautions, First Aid and awareness on epidemic/sporadic diseases.</p>	14
<b>References</b>		
<ol style="list-style-type: none"> <li>1. Bamji, M.S., K. Krishnaswamy &amp; G.N.V. Brahmam (2009) Textbook of Human Nutrition (3rd edition) Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.</li> <li>2. Swaminathan (1995) Food &amp; Nutrition(Vol I, Second Edition) The Bangalore Printing &amp;Publishing Co Ltd., , Bangalore.</li> <li>3. Vijaya Khader (2000) Food, nutrition &amp; health, Kalyan Publishers, New Delhi.</li> <li>4. Srilakshmi, B., (2010) Food Science, (5th Edition) New Age International Ltd., New Delhi.</li> <li>5. Weblinks: <a href="https://nhm.gov.in/">https://nhm.gov.in/</a></li> <li>6. Park and Park, 1995: Text Book of Preventive and Social Medicine –Banarsidas Bhanot Publ. Jodhpur – India.</li> <li>7. Verma, S. 1998: Medical Zoology, Rastogi publ. – Meerut – India 2. Singh, H.S. and Rastogi, P. 2009: Parasitology, Rastogi Publ. India. 3. Dubey, R.C and Maheswari, D.K. 2007: Text Book of Microbiology- S. Chand &amp; Co. Publ. New Delhi – India.</li> </ol>		

## GEC 2: C) Human reproductive health issues and Sex Education

<b>Course Title:</b> C) Human reproductive health issues and Sex Education	<b>Course code:</b> 24ZOO4G2CL
<b>Total Contact Hours:</b> 28 (02 L-0-0)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 1 h
<b>Summative Assessment Marks:</b> 30	

### Course Outcomes (COs):

#### At the end of the course, students will be able to:

1. Gain Knowledge on clean sexual habits thereby warding off sexually transmitted diseases.
2. Distinguish the structure and functions of the male and female reproductive system. Significance of hormones in pregnancy, parturition and lactation.
3. Understand the process of human reproduction.
4. Appreciate the importance of relationships within and outside the family and to understand their changing nature.
5. Consolidate understanding of the nature and methods of transmission of HIV/AIDS and other sexually transmitted diseases.

Unit	Description	Hours
1	<b>Human Reproductive physiology</b> – Reproductive systems of Male and Female. Brief Description and Hormonal regulation of Gametogenesis, Onset of Puberty, Menstrual cycle, Menopause – Causes for concern, Psychosocial adjustments, Fertilization, Implantation, Pregnancy and parturition. Assisted Reproduction: In-utero -fertilization and test tube baby – Legal and Ethical issues	14
2	<b>Reproductive Health</b> – Meaning, objectives, goals and Issues related to reproductive health. Sexual health and Sexually transmitted Diseases - Syphilis, Gonorrhoea, Chlamydia, Genital Herpes and AIDS. Intended and unintended pregnancies – teenage pregnancy. Infertility and Factors causing infertility – Stress, Problems in ovulation, blocked or scarred fallopian tubes, endometriosis and low sperm count. Sex education: Adolescent sexual activity, teenage pregnancy, sexual harassment, sexual awareness and policies (legal aspects), lesbian and gay-sex, bisexual, transgender youth, adolescent stress management.	14
<b>References (indicative)</b>		
<ol style="list-style-type: none"> <li>1. Common sexual problems and solutions by Dr. Prakash Kothari, UBS Publishers and Distributors Ltd.</li> <li>2. Guyton &amp; Hall. Textbook of Medical Physiology.</li> <li>3. Mac E. Hadley. Endocrinology. Pearson Education, Singapore.</li> <li>4. Turner, CD and Bagnara, J.T. General and Comparative Endocrinology, 1998.</li> </ol>		

## DSC11 L9: Biodiversity and Conservation Lab

<b>Course Title:</b> Biodiversity and Conservation Lab	<b>Course code:</b> 24ZOO4C11P
<b>Total Contact Hours:</b> 56 (0-0-4P/week)	<b>Course Credits:</b> 02
<b>Formative Assessment Marks:</b> 20	<b>Duration of ESA/Exam:</b> 4 h
<b>Summative Assessment Marks:</b> 30	

### Course Outcomes (CO's):

#### At the end of the course, students will be able to:

1. Interpret basics of science of biodiversity conservation covered in Modules
2. Study the animals around us and their significance.
3. Know the importance of understanding the legal context for conservation management.
4. Know the main elements of the legal framework that underpins biodiversity conservation nationally and internationally.

SL No	List of experiments	Hours
1	Determine the required size of quadrant to study the vegetation by species area curve method.	4
2	Determine the required number of quadrat to study the vegetation in a given area by species area curve method.	4
3	Analyze the vegetation by quadrat method. i. Line transect method ii. Belt transect method	4
4	Estimate the litter arthropod diversity by a trap method.	4
5	Analyze the population structure of tree species in a given area.	4
6	Estimate the standing forest floor litter.	4
7	Nutrients cycling in forest: Soil sampling & Organic carbon analysis.	4
8	Identify marine and fresh water planktons (preserved water samples may be used).	4
9	Separate, mount and study the appendages of prawn ;penaeid and non-penaeid.	4
10	Study of animal architecture (photographs / diagram / abandoned specimen); Hive of honey bee, nest of paper wasp, nest of potter wasp, Mount of termite, Nests of Weaver Bird and tailor bird.	4
11	Comparative study of mouth parts (preserved specimen / diagrams only); House fly, female Mosquito, Cockroach, Butterfly / moth, Bug, beetle.	4
12	Using photographs / paintings / coloured drawings identify and study distribution and ecological role of common bivalves and gastropods that occur along a sea-shore.	4
13	Compare and interpret given sonograms of bird calls (any two e.g. Courtship calls, Alarm calls)	4

14	Identify and describe false colour images of land use patterns from a satellite image; City, reservoir, forest, agricultural land, sea-shore.	4
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1. EIA – A Biography Clark, B. D., Bissel, B. D. and Watheam, P. School of Forestry and Environment, SHIATS Deemed University, Allahabad.</li> <li>2. Wildlife Ecology, Conservation and Management Anthony R.E. Sinclair, John M. Fryxell and Graeme Caughly Blackwell Publishing, U.S.A. 2006.</li> <li>3. Collection and preservation of animals Jairajpuri M. S. Zoological Survey of India 1990</li> <li>4. Biodiversity conservation in managed and protected areas Katwal/Banerjee Agrobios, India 2002.</li> <li>5. Biodiversity and its conservation in India Negi, S.S. Indus Publishing Co., New Delhi. 1993.</li> <li>6. Wildlife Ecology, Conservation and Management Sinclair, Anthony R.E., Fryxell, John M. and Caughly, Graeme Blackwell Publishing, U.S.A. 2006.</li> <li>7. Vertebrate Zoology and Evolution. Yadav, B.N. IBD, Dehradun. 2000</li> <li>8. Indian Wildlife Resources Ecology and Development Sharma, B.D Daya Publishing House, Delh</li> <li>9. Collection and preservation of animals Jairajpuri M. S. Zoological Survey of India 1990</li> </ol>		

## Project: Research Project

<b>Course Title:</b> Research Project	<b>Course code:</b> 24ZOO4C1R
<b>Total Contact Hours:</b> 56 (0-0-8P/week)	<b>Course Credits:</b> 04
<b>Formative Assessment Marks:</b> 30	<b>Duration of ESA/Exam:</b> 4 h
<b>Summative Assessment Marks:</b> 70	

### Course Outcomes (CO's):

#### At the end of the course, students will be able to:

To do independent research at national and international standard.

**Aim:** (a) Application of knowledge to real life situation (b) to introduce research methodology. Topic of dissertation may be chosen from any area of Zoology and may be laboratory based, field based or both or computational, with emphasis on originality of approach. It may be started during 3<sup>rd</sup> /4<sup>th</sup> semester and shall be completed by the end of the 4<sup>th</sup> semester. The Dissertation to be submitted should include (a) background information in the form of introduction (b) objectives of the study (c) materials and methods employed for the study (d) results and discussion thereon (e) summary and conclusions and (f) bibliography. Apart from these sections, importance of the results, originality and general presentation also may be taken into consideration for evaluation.

**CBCS Question Paper Pattern for M.Sc. Zoology Semester End**  
**Examination with Effect from the AY 2024-25**

**Disciplines Specific Core (DSC) and Discipline Specific Elective (DSE)**

**Paper Code:**

**Time: 3 Hours**

**Note: Answer any *FIVE* of the following, each question carries equal marks Question No.1 is Compulsary.**

**Paper Title:**

**Max. Marks: 70**

Q1.	A	7 Marks
	B	7 Marks
Q2.		14 Marks
Q3.		14 Marks
Q4.		14 Marks
Q5.		14 Marks
Q6		14 Marks
Q7		14 Marks
Q8	A	7 Marks
	B	7 Marks

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## **Skill Enhancement Courses (SECs)**

**Paper Code:**

**Time: 1 Hours**

**Paper Title:**

**Max. Marks: 30**

**There shall be Theory examination of Multiple Choice Based Questions [MCQs] with Question Paper set of A, B, C and D Series at the end of each semester for SECs for the duration of One hour (First Fifteen Minutes for the Preparation of OMR and remaining Forty-Five Minutes for Answering thirty Questions). The Answer Paper is of OMR (Optical Mark Reader) Sheet.**

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## **General Elective Course**

**Paper Code:**

**Time: 1 hr.**

**Paper Title**

**Marks: 30**

There shall be theory examination

I containing five compulsory questions of one mark each.

II Answer any five questions of two marks each with two choice (total 7 questions)

III. Answer any three questions of five marks each with two choice (Total 5 questions)

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