RAJAH SERFOJI GOVT COLLEGE (Automonous), THANJAVUR-5

M. Sc. ZOOLOGY

Course Introduction: M. Sc. Zoology

Program's General Objective

The Master of Zoology program curriculum is designed to enable them to deepen their knowledge of fundamental concepts and development in modern biology. There are no limits to their choice of learning, they can expand their knowledge in their favorite subject from online courses (MOOC, SWAYAM, NPTEL) through credit transfer system. This program train students in teaching and research projects and preparing them for a career in biology related fields, advancement from graduate students, teaching, public and private services. In addition, one full semester for dissertation-based program allows everyone to gain the desired experience, either at our department laboratories, which are fully- equipped for contemporary applications in modern biology, or in other academic, industries and governmental laboratories. After completing the program, they will have a specific competence profile and be able to analyze complex concepts in their field of study, as well as plan and carry out experiments. Finally, this program provides a solid foundation to respond to the challenges of the 21st century in the biological sciences.

Program Outcome (PO)

The M.Sc. Zoology program provides a transformative learning experience that prepares graduates to make significant contributions to society. Through a rigorous curriculum, students develop critical thinking, problem-solving, and research capabilities while making meaningful connections across disciplines. The program actively supports the Institution's vision of achieving national and international distinction through interdisciplinary collaboration, extramurally funded research, and high-impact publications.

PO1 (Domain Expertise & Research Focus): Comprehensive and in-depth knowledge of advanced zoological concepts, culminating in a dedicated one-semester thesis research project.

PO2 (Curriculum & Lifelong Learning): A rigorous, student-centric curriculum integrated with research and modern technology to establish a strong foundation for lifelong learning.

PO3 (Specialized & Interdisciplinary Knowledge): Exposure to diverse biological domains spanning classical to modern applications, including specialized fields such as Behavioral Neuroscience, Aquaculture, Nanobiotechnology, Cancer Biology, Reproductive Technology, and Stem Cell Therapeutics in Neuronal Disorders.

PO4 (Global Competence & Problem Solving): Specialized domain training designed to equip graduates to address complex biological and environmental challenges at national and international levels.

PO5 (Experimental & Evidence-Based Learning): Practical mastery through balanced laboratory coursework, focusing on hypothesis formulation, experimental design, systematic observation, and data interpretation.

PO6 (Quantitative Reasoning & Data Analytics): Proficiency in mathematical reasoning and biostatistics, enabling students to apply descriptive and inferential methods, design experiments, analyze complex datasets, and evaluate probabilistic models.

PO7 (Scientific Communication): Strong scientific communication skills cultivated through structured seminars, data visualization, technical writing, and oral presentations.

PO8 (Societal Impact & Sustainability): Understanding of the intersection between biological sciences and society, empowering graduates to contribute to public health systems, economic growth, and sustainable environmental practices.

PO9 (Original Research & Innovation): Engagement in original, rigorous scientific research that advances scholarly understanding and drives innovation within specialized biological disciplines.

PO10 (Academic & Career Excellence): High academic achievement (CGPA $\geq$ 9.0) establishing mastery of core biological tenets, preparing graduates to excel in national eligibility examinations (e.g., CSIR-NET/GATE) and launch successful careers in academia, research, or industry.

Program Specific Outcome (PSO)

PSO1 (Knowledge Expansion): Gain in-depth understanding of complex biological concepts at cellular and molecular levels, demonstrating the ability to articulate and apply this knowledge to advanced biological problems.

PSO2 (Specialization & Lifelong Learning): Pursue specialized expertise within biological sciences by acquiring additional credits in advanced and emerging sub-disciplines.

PSO3 (Laboratory & Practical Skills): Acquire hands-on proficiency in diverse research techniques through integrated laboratory components, bridging theoretical concepts with experimental applications.

PSO4 (Instrumentation & Experimental Design): Master the operational principles, proper calibration, and application of modern scientific instrumentation and methodology in experimental design.

PSO5 (Scientific Documentation & Reporting): Develop professional reporting skills through field and laboratory documentation, presenting structured results and analytical discussions suitable for professional and scholarly contexts.

PSO6 (Field Inquiry & Critical Thinking): Enhance observational and analytical skills through field and academic visits, enabling effective data collection, hypothesis testing, and conceptual modelling.

PSO7 (Scientific Communication): Cultivate effective oral communication abilities through structured scientific seminars, formal presentations, and collaborative academic discourse.

PSO8 (Quantitative & Numerical Literacy): Apply mathematical concepts, statistical tools, and quantitative equations to analyze experimental datasets and derive scientifically valid conclusions.

PSO9 (Critical Inquiry & Knowledge Synthesis): Develop advanced skills in critical literature review, gap identification, scientific question formulation, and the synthesis of innovative research concepts.

PSO10 (Research Autonomy & Career Readiness): Execute an independent research thesis by conceptualizing, designing, and performing experiments, thereby building advanced technical proficiency and research capability for academic and industrial careers.

RAJAH SERFOJI GOVT COLLEGE (AUTOMONOUS), THANJAVUR-5
POST GRADUATE COURSES
SUBJECT: ZOOLOGY
(Applicable to the Students admitted from the academic year 2026-2027 onwards)

SEM	CODE	COURSE	TITLE	HRS / WEEK	MARKS		TOTAL	EXAM HOURS	CREDIT
			I SEMESTER		IA	AE			
I	**B1PZOC1**	**CC1**	Structure and Function of Invertebrates	6	30	70	100	3	6
	B1PZOC2	**CC2**	Comparative Anatomy of Vertebrates	6	30	70	100	3	6
	B1PZOC3	**CC3**	Biochemistry	6	30	70	100	3	6
	B1PZOC4P	**CC4**	Laboratory Course I	6	40	60	100	3	6
	BPZOECA	**EC-1**	Biostatistics	6	30	70	100	3	6
		TOTAL		**30**			**500**		**30**
			II SEMESTER						
II	**B2PZOC5**	**CC5**	Cellular and Molecular Biology	6	30	70	100	3	6
	B2PZOC6	**CC6**	Developmental Biology	6	30	70	100	3	6
	B2PZOC7	**CC7**	Environmental Biology	6	30	70	100	3	6
	B2PZOC8P	**CC8**	Laboratory Course II	6	40	60	100	3	6
	BPZOECB	**EC2**	*Will be Chosen from the List of Electives*	6	30	70	100	3	6
		TOTAL		**30**			**500**		**30**
			III SEMESTER						
III	**B3PZOC9**	**CC9**	Genetics	6	30	70	100	3	6
	B3PZOC10	**CC10**	Animal Physiology	6	30	70	100	3	6
	B3PZOC11P	**CC11**	Laboratory Course III	6	40	60	100	3	6
	B3PZOC12	**CC12**	Research Methodology	6	30	70	100	3	6
	BPZOECC	**EC3**	*Will be Choosen from the List of Electives*	6	30	70	100	3	6
	BPZOINTEN	**Internship / Industrial activity**		-	-	-	-	-	2
		TOTAL		**30**			**500**		**32**
			IV SEMESTER						
IV	**B4PZOC13**	**CC13**	Immunology	6	30	70	100	3	6
	B4PZOC14P	**CC14**	Laboratory Course IV	6	40	60	100	3	6

	B4PZOC15	**CC15**	***Project Work***	6	40	60	100	3	6
	BPZOECD	**EC4**	*Will be Chosen from the List of Electives*	6	30	70	100	3	6
	B4PZOSE1	**SEC1**	Aquaculture	3	30	70	100	3	3
	B4PZOSE2	**SEC2**	Sericulture	3	30	70	100	3	3
			Extension Activity						1
		TOTAL		**30**			**600**		**31**
		GRAND TOTAL					**2000**		**123**

	Number of Papers	**Credit**
Core courses	**15**	**90**
Elective courses	**4**	**24**
Internship/ Industrial activity		**2**
Skill Enhance	**2**	**6**
Extension Activity		**1**
Total	**21**	**123**

Elective Courses

BPZOECA	Biostatistics
BPZOECB	Poultry Farming
BPZOECC	Evolution
BPZOECD	Medical Laboratory Techniques

Skill Enhancement Course

BPZOSE1A	Aquaculture
BPZOSE1B	Sericulture
BPZOSE2A	Vermiculture
BPZOSE2B	Bee Keeping

Course		Core Course I				Code	B1PZOC1
STRUCTURE AND FUNCTION OF INVERTEBRATES							
Credits	6	Semester		I		Hours/Week	6
Marks	CIA	30	Ext	70		Total	100

Learning Objectives:

The main objectives of this course are:

LO1	To understand the concept of classification and their characteristic features of major group of invertebrates
LO2	To realize the range of diversification of invertebrate animals
LO3	To enable to find out the ancestors or derivatives of any taxon
LO4	To know the functional morphology and system biology of invertebrates
LO5	To have a detailed comparison of the anatomy of the different taxa of non-chordates.

Pre-requisite:

Students should know the taxonomical classification of invertebrate animals in relation to their functional morphology.

Unit I	Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy
Unit II	Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata
Unit III	Nutrition and Digestion: Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory pigments; Mechanism of respiration
Unit IV	Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malphigian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and lnsecta) and Mollusca (Cephalopoda); Trends in neural evolution
Unit V	Invertebrate larvae: Larval forms of free-living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters

Reading list

Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.

Recommended texts

Barnes, R. D. 1974. Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition, pp-1024.

Barnes, R. S. K., P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. 2013. The Invertebrates: A Synthesis. Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi.

Dechenik, J. A. 2015. Biology of Invertebrates (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.

Expected Learning Outcome:

On the successful completion of the course, student will be able to**:**

LO1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	K1 K2
LO2	Understand the evolutionary process. All are linked in a sequence of life patterns.	K2 K4
LO3	Apply this for pre-professional work in agriculture and conservation of life forms.	K3 K5
LO4	Analyze what lies beyond our present knowledge of life process.	K4 K6
LO5	Evaluate and to create the perfect phylogenetic relationship in classification.	K5 K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Mapping with Programme Outcomes*

Los	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
LO1	S	S	M	S	S	S	M	S	S	S
LO2	S	S	M	M	S	S	M	M	S	S
LO3	S	M	S	M	S	S	M	M	S	S
LO4	S	M	S	M	S	S	M	M	S	M
LO5	S	M	S	M	S	S	M	M	S	M

*S - Strong; M - Medium; L - Low

Course	Core Course II	Code	B1PZOC2
COMPARATIVE ANATOMY OF VERTEBRATES			

Credits	6	Semester	I	Hours/Week	6
Marks	CIA	30	Ext	70	Total	100

Learning Objectives:

The main objectives of this course are:

LO1	Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.
LO2	Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.
LO3	Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals
LO4	Imparting conceptual knowledge about the animal life in the air and their behaviour
LO5	Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.

Pre-requisite:

Students with knowledge and comprehension on zoology.

Unit I	Origin of vertebrates: Protochordata; The nature of vertebrate morphology; Definition, scope and relation to other disciplines; Importance of the study of vertebrate morphology.
Unit II	Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.
Unit III	General plan of circulation in various groups; Blood; Evolution of heart; Evolution of aortic arches and portal systems. Respiratory system: Characters of respiratory tissue; Internal and external respiration; Comparative account of respiratory organs
Unit IV	Skeletal system: Form, function, body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrate series.
Unit V	Sense organs: Simple receptors; Organs of Olfaction and taste; Lateral line system; Electroreception. Nervous system: Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinal cord; Nerves-Cranial, Peripheral and Autonomous nervous systems.

Reading list

Swayam Prabha https://www.swayamprabha.gov.in/index.php/program/archive/9

Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.

Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.

Recommended texts

Waterman, A.J. 1972. Chordate Structure and Function, MacMillan Co., New York, pp.587.

Parker T. J. and W. A. Haswell. 1962. A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750.

Ekambaranatha Ayyar and T. N. Ananthakrishnan. 2009. Manual of Zoology, Vol – II, S. Viswanathan Pvt. Ltd. Chennai.

Kotpal, 2019. R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut, pp-968.

Expected Learning Outcome:

On the successful completion of the course, student will be able to**:**		
LO1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	K1 K2
LO2	Understand the evolutionary process. All are linked in a sequence of life patterns.	K2 . K4
LO3	Apply this for pre-professional work in agriculture and conservation of life forms.	K3 . K5
LO4	Analyze what lies beyond our present knowledge of life process.	K4 . K6
LO5	Evaluate and to create the perfect phylogenetic relationship in classification.	K5 . K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Mapping with Programme Outcomes*

LOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
LO1	S	M	L	S	M	S	M	S	M	S
LO2	S	L	L	S	M	S	M	M	M	M
LO3	S	M	L	S	M	S	M	L	M	M
LO4	S	L	L	S	L	S	M	L	M	L
LO5	S	M	L	S	S	S	M	S	M	M

*S - Strong; M - Medium; L – Low

Course	Core Course III	Code	B1PZOC3
BIOCHEMISTRY			

Credits	6	Semester	I	Hours/Week	6
Marks	CIA	30	Ext	70	Total	100

Course Objectives:

The main objectives of this course are:

Students should know the fundamentals of biochemistry

LO1	To enable students to learn basic concepts of carbohydrate and their metabolism
LO2	The basic structure, functions and metabolism of proteins
LO3	To learn the functions, metabolism of lipids
LO4	To learn the structure and types of nucleic acids and vitamins
LO5	To study the structure and classification of hormones and signalling pathways

Pre-requisite:

Understanding fundamental properties of elements, atoms, molecules, chemical bonds, linkages and structure, composition, metabolism and functions of biomolecules.

Unit I	Carbohydrates: Classification, structure, properties and functions. Metabolism of carbohydrate: Glycolysis - TCA cycle – Glycogenolysis – Glycogenesis - Gluconeogenesis - HMP shunt pathway - Oxidative Phosphorylation
Unit II	Proteins: Classification and functions. Properties of amino acids. Structure of protein (Primary, Secondary, Tertiary, Quaternary). Enzymes: classification and properties. Enzyme kinetics - Enzyme inhibition, Mechanism of Enzyme catalysis.
Unit III	Lipids: Classification, properties and biological functions. Biosynthesis of fatty acids, Triglycerides, cholesterol, Phospholipids, Ketogenesis. Beta oxidation of fatty acids
Unit IV	Nucleic acids' structural organization: structure of DNA (A, B, Z forms) and RNA (mRNA, tRNA, rRNA, SnRNA). Synthesis and degradation of purine and pyrimidines (Denovo and Salvage pathways). Vitamins: Classification and functions. Minerals: functions
Unit V	Hormones: Structure, classification, hormonal receptors: Steroid hormone receptor, peptide hormone receptor, signalling through G-protein coupled receptors - Signal transduction pathway, cAMP, cGMP, phosphatidyl, inositol and calcium as secondary messenger. Hormonal regulation and signal transduction

Reading list

1. Berg, J. M., J. L. Tymoczko and L. Stryer 2002. Biochemistry. 5th Ed., W.H. Freeman & Co., New York, pp-1050.

2. Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.

3. McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7th Edition). Oxford University Press, US, pp-793.

4. Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.

5. Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.

Recommended texts

1. Buchanan, B.B., W. Gruissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp-1280.
2. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26th Edition), The McGraw-Hill Companies, Inc., USA, pp-704.
3. Palmer, T. 2004. Enzymes. Affiliated East-West Press Pvt. Ltd., New Delhi, pp-416.
4. Voet D. and J.G. Voet. 2011. Biochemistry. (4th Edition). John Wiley & Sons (Asia) Pvt. Ltd., pp-1428.

Expected Learning Outcome:		
On the successful completion of the course, student will be able to:		
LO1	To understand the chemical nature of life and life process	K1 & K3
LO2	To provide an idea on structure and functioning of biologically important molecules	K1 & K2
LO3	To generate an interest in the subject and help students explore the new developments in Biochemistry.	K2 & K3
LO4	To understand the importance of metabolism of bio macromolecules in normal physiology of a man	K2 & K4
LO5	To understand the abnormal metabolism of biomolecules and the resultant diseases	K5 & K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Creat

Mapping with Programme Outcomes*										
LOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
LO1	M	S	M	S	L	S	M	S	M	M
LO2	S	S	L	S	S	S	M	M	M	S
LO3	M	M	M	S	M	S	S	S	S	L
LO4	S	M	S	M	S	M	S	S	S	M
LO5	M	S	S	M	M	S	M	L	S	M

*S - Strong; M - Medium; L-Low

Course	Core Course IV	Code	B1PZOC4P

LABORATORY COURSE I:
INVERTEBRATES, VERTEBRATES & BIOCHEMISTRY

Credits	6	Semester	I	Hours/Week	6

Marks	CIA	40	Ext	60	Total	100

Learning Objectives:

The main objectives of this course are:

LO1	Understanding the different systems in invertebrates & vertebrates.
LO2	Learning about various animal species, their phylogenetic affinities and their adaptive features
LO3	Imparting conceptual knowledge about the salient features and functional anatomy.
LO4	Developing the skill in mounting techniques of the biological samples.
LO5	Gaining fundamental knowledge on the skeletal system

Pre-requisite:

Basic knowledge on the animals living in different habitats

Expected Learning Outcome:

On the successful completion of the course, student will be able to**:**

LO1	understand the structure and functions of various systems in animals	**K2 & K4**
LO2	learn the adaptive features of different groups of animals	**K1 & K2**
LO3	learn the mounting techniques	**K2 & K3**
LO4	acquire strong knowledge on the animal skeletal system	**K2 & K4**
LO5	develop skills in biochemistry of life	**K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

INVERTEBRATES

Dissection

Earthworm : Nervous system
Cockroach : Digestive system, Nervous system
Prawn : Nervous system, Appendages

Study of the following slides with special reference to their salient features and their modes of life

1. *Amoeba*
2. *Entamoeba histolytica*
3. *Paramecium*
4. *Hydra* with bud
5. Sporocyst – Liver fluke
6. *Cercaria* larva
7. *Tape worm (Scolex)*
8. *Ascaris* T. S.
9. Mysis of prawn

Spotters

1. Scorpion
2. *Penaeus indicus*
3. *Emerita* (*Hippa*)
4. *Perna viridis*

Mounting

Earthworm : Body setae
Cockroach : Mouth parts
Honey bee : Mouth parts

CHORDATES

Study of the following specimens with special reference to their salient features and their modes of life

1. *Amphioxus* sp. (Lancelet)
2. *Ascidia* sp. (sea squirt)
3. *Scoliodon laticaudatus* (Indian dog shark)
4. *Trygon* sp. (Sting ray)
5. *Torpedo* sp. (Electric ray)
6. *Arius maculatus* (Cat fish)
7. *Belone cancila* (Flute fish)
8. *Exocoetus poecilopterus* (Flying fish)
9. *Mugil cephalus* (Mullet)
10. *Tilapia mossambicus* (Tilapia)
11. *Rachycentron canadum* (Cobia)
12. *Tetrodon punctatus* (Puffer fish)
13. *Dendrophis* sp. (Tree snake)

Study of the different types of scales in fishes

1. Cycloid scale
2. Ctenoid scale
3. Placoid scale

Study of the frog skeleton system (Representative samples)

1. Entire skeleton
2. Skull
3. Hyoid apparatus
4. Pectoral girdle and sternum
5. Pelvic girdle
6. Fore limb
7. Hind limb

BIOCHEMISTRY

1. Quantification of Carbohydrates
2. Quantification of Protein
3. Quantification of Lipids

Spotters

Amino Acid Structure, Colorimeter, pH meter,

Field visit to ecologically important places

Text Books:

1. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.

2. Iuliis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp-416.
3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528

Reference Books:

1. Preeti, G., and C. Mridula, 2000. Modern Experimental Zoology, Indus International Publication.
2. Sinha, J., A. K. Chatterjeee, P. Chattopadhya. 2011. Advanced Practical Zoology, Arunabha Sen Publishers, pp-1070.

Mapping with Programme Outcomes*										
LOs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
LO1	S	S	S	M	S	S	M	S	M	S
LO2	S	M	L	S	M	S	M	M	M	M
LO3	M	M	L	S	L	S	M	L	M	M
LO4	S	S	L	S	L	S	M	L	M	L
LO5	S	S	M	L	M	S	M	S	M	M

*S - Strong; M - Medium; L - Low

Course	Core Course V	Code	B2PZOC5
CELLULAR AND MOLECULAR BIOLOGY			

Credits	6	Semester	II	Hours/Week	6
Marks	CIA	30	Ext	70	Total	100

Learning Objectives:

The main objectives of this course are:

LO1	To understand the ultra-structures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.
LO2	To realize involvement of various cellular components in accomplishing cell division.
LO3	To impart mechanisms involved in cell communication and signalling using examples.
LO4	To provide students with relevant knowledge, skills, and values in contemporary molecular cell biology.
LO5	To enrich knowledge about cancer/oncogenes, virus-induced cancer, therapies, cellular morphology, and markers

Pre-requisite:

Students should have knowledge of the basic cellular structures and their salient functions in prokaryotic and eukaryotic cells.

Unit I	General features of the cell: Basic structure of prokaryotic and eukaryotic cells - Protoplasm and deutroplasm - cell organelles; cell theory; Diversity of cell size and shapes.
Unit II	Cellular organization: Membrane structure and functions - Structure of model membrane, lipid bilayer and membrane proteins diffusion, osmosis, ion channels, active transport, ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles and chloroplasts.
Unit III	Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Molecular biology of cell: Structure of DNA and RNA; Process of DNA replication, transcription and translation in pro- and eukaryotic cells; Genetic maps.
Unit IV	Cell communication and cell signalling: Membrane- associated receptors for peptide and steroid hormones - signalling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures.
Unit V	Cancer cells: Characteristic features of normal and cancer cells; Carcinogens: types and cancer induction; Metastasis; Oncogenes and tumor suppressor genes, apoptosis; therapeutic interventions of uncontrolled cell growth.

Expected Learning Outcome:

Upon completion of this course, students could

LO1	Understand the general concepts of cell and molecular biology.	**K2**
LO2	Visualize the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance of molecular and cellular structures influencing functional features.	**K1 K2**
LO3	Perceive the importance of physical and chemical signals at the molecular level resulting in modulation of response of cellular responses.	**K3 K4**

LO4	Updated the knowledge on the rapid advances in cell and molecular biology for a better understanding of onset of various diseases including cancer.	**K5**
LO5	Understand the general communication of cell and the role of hormones and their functional mechanism	**K2**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

Plopper, G., D. Sharp, and E. Sikorski. 2015. Lewin's Cells (Third Edition), Jones & Bartlett, New Delhi, pp-1056

Plopper, G. 2013. Principles of Cell Biology, Jones & Bartlett, Maryland, pp-510

Recommended texts

1. Karp, G. 2010. Cell Biology (Sixth Edition), John Wiley & Sons, Singapore, pp-765.
2. Lodish, H., C. A. Kaiser, A. Bretscher, *et al*., 2013. Molecular Cell Biology (Seventh Edition), Macmillan, England, pp-1154
3. De Robertis, E.D.P. and E. M. F. De Robertis Jr, 1987. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734
4. Abbas, A. K., A. H. Lichtman and S. Pillai, 2007, Cell and Molecular Immunology (Sixth Edition), Saunders, Philadelphia, pp-566
5. Loewy, A.G., P. Siekevitz and J. R. Menninger, *et al*., 1991, Cell Structure and Function (Third Edition), Saunders, Philadelphia, pp-947
6. Watson, J. D., N.H. Hopkins, J.W. Roberts, *et al*., 1987, Molecular Biology of the Gene (Fourth Edition), Benjamin/Cummings, California, pp-1163
7. Han, S. S. and J. Holmstedt. 1979, Cell Biology, McGraw Hill, pp-319

Mapping with Programme Outcomes*

LOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
LO1	L	L	L	L	S	S	S	M	M	M
LO2	M	M	M	S	S	S	S	M	S	M
LO3	S	S	S	M	M	S	M	M	L	S
LO4	M	M	S	L	S	S	L	M	S	S
LO5	S	M	M	S	S	S	S	M	S	S

*S - Strong; M - Medium; L – Low

Course	Core Course VI	Code	B2PZOC6
DEVELOPMENTAL BIOLOGY			

Credits	6	Semester	II	Hours/Week	6
Marks	CIA	30	Ext	70	Total	100

Course Learning Objectives:

The main objectives of this course are:

LO1	Understand the process of gametogenesis, cleavage and gastrulation, embryonic development, extra embryonic membrane and placenta in various animals and human.
LO2	To emphasize embryonic organizers, the nature of genetic information during cell differentiation
LO3	To compare the types of eggs, cleavage patterns, and developmental fate.
LO4	Learn the principles, methods and applications of cryo-preservation of gametes and embryo
LO5	To discuss the molecular regulation of organogenesis and regeneration in amphibians and reptiles

Pre-requisite:

Students have fundamental knowledge in developmental biology.

Unit I	Pattern of animal development: Chief events in animal development; History of thoughts and conceptual developments. Gametogenesis: Origin of germ cells, spermatogenesis - Sperm morphology in relation to the type of fertilization, Oogenesis - Oogenesis in insects and amphibians; Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians
Unit II	Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitation in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg - Egg activation - Intracellular calcium release - Cortical reaction - Physiological polyspermy - Fusion of male and female pronuclei - Post fertilization metabolic activation - Parthenogenesis
Unit III	Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition - Determinate and regulatory embryos, Factors affecting gastrulation, mechanisms and types of gastrulation in respective animal embryos (Sea urchin, *Amphioxus*, Amphibians, Aves, Mammals); Fate maps - (Amphibian and Chick), Epigenesis and preformation – Formation of primary germ layers
Unit IV	Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation; Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Gene and development; Anterior- posterior axis in determination in drosophila, Maternal effect genes - *Bicoid* and *Nanos* proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes
Unit V	Post embryonic development: metamorphosis-Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects. Neoteny and pedogenesis. Regeneration: Formation of ectodermal cap and regeneration blastema - Types of regeneration

	in planaria, Regenerative ability in different animal groups, Factors stimulating regeneration – Biochemical changes associated with regeneration. Aging and senescence: Biology of senescence- cause of aging- mechanism involved in apoptosis. IVF and assisted reproductive technologies. Cryopreservation of gametes/embryos - Ethical issues in cryopreservation

Expected Course Outcome:

On the successful completion of the course, student will be able to

LO1	Define the concepts of embryonic development	**K1**
LO2	Observe various stages of cell divisions under microscope	**K2, K3**
LO3	Understand the formation of zygote	**K4**
LO4	Differentiate the blastula and gastrula stages	**K4, K5**
LO5	Learn the distinguishing features of three different germ layers and formation of various tissues and organs	**K4**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

1	Balinsky, B. I. 1981. Introduction to Embryology (5th Edition), CBS College Publishers, New York, pp-782.
2	Gilbert. S. F. 2006. Developmental Biology, 8th Edition, INC Publishers, USA, pp-785.
3	Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.
4	Tyler, M.S. 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA, pp-208.

Recommended texts

1	Wilt, F.H. and N.K. Wessel. 1967. Methods in Developmental Biology, Thomas Y Crowell, New York
2	Slack, J.M.W. 2012. Essential Developmental Biology. Wily-Blackwell Publications, USA, pp-496
3	Mari-Beffa, M. and J. Knight. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	S	S	L	S	M	L	M
CO2	S	S	S	S	S	L	S	S	S	S
CO3	S	M	S	S	S	S	S	L	L	M
CO4	S	S	S	S	S	M	S	S	S	L
CO5	S	S	S	M	S	S	S	L	L	M

*S - Strong; M - Medium; L – Low

Course	Core Course VII	Code	B2PZOC7
ENVIRONMENTAL BIOLOGY			
Credits	6	Semester	II
Hours/Week	6		

Marks	CIA	30	Ext	70	Total	100

Course Objectives:

The main objectives of this course are:

LO1	To detail the structural and functional mechanics of terrestrial, freshwater, marine, and estuarine ecosystems, emphasizing energy transformations and biogeochemical cycles
LO2	To examine the concepts of fundamental and realized niches, resource partitioning, population growth kinetics, age structures, and life-history strategies (r and K selection).
LO3	To analyze interspecific behaviors (competition, symbiosis, predation), ecotones, edge effects, and the mechanisms governing ecological succession toward climax communities.
LO4	To evaluate the drivers of global environmental change, principles of environmental pollution, waste management strategies, and methods for monitoring biodiversity.
LO5	To assess biogeographical theories (including Island Biogeography) and evaluate national conservation strategies such as Project Tiger, Biosphere Reserves, and Indian biogeographical zones.

Pre-requisite:

Students should know about the fundamentals and studied the ecology of living organisms.

Unit I	The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
Unit II	Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation-demes and dispersal, interdemic extinctions, age structured populations -action taken to control population explosion.
Unit III	Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax
Unit IV	Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
Unit V	Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches - Waste management. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Expected Learning Outcome:

On the successful completion of the course, student will be able to

LO1	Learn about the ecosystem, biotic communities and utilizing the energy processing	K2
LO2	Study the various community and population and population control	K2, K3
LO3	Understand the fundamentals of climatic conditions and its impact on environment	K2, K6
LO4	Realizing the nature of pollution and the ways for its control/reduction	K4, K5
LO5	Impact of environmental studies on solid waste management	K2, K6

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** - Create

Reading list

1. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publication, India, pp-616.
2. Calabrese, E.J. 1978. Pollutants and High-Risk Groups, John Wiley, pp-286.
3. Raven, P.H. and L.R. Berg, G.B. Johnson, 1993. Environment, Saunders College Publishing, pp-579.
4. Cunningham, W. P. and B. W. Saigo, 1999. Environmental Science, McGraw Hill Boston, 5th Edition.
5. Class central.com/course/Swayam -ecology - and environment – 14021.

Recommended texts

1. Odum, E.P. 1893. Basic Ecology, Saunders & Co., Philadelphia, pp-383.
2. Barthwl, R.R. 2002. Environmental Impact Assessment, New Age International Publishers, New Delhi, India, pp-425.
3. United Nations Environment Programme (UNEP). 1995. Global Biodiversity Assessment, Cambridge University Press, pp-1140.

Mapping with Programme Outcomes*

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	S	M	S	S	M	S
CO2	S	S	M	M	L	S	S	S	M	M
CO3	S	M	M	L	M	S	L	L	S	L
CO4	M	M	S	S	M	L	L	S	S	S
CO5	M	S	S	M	S	M	L	M	L	S

*S - Strong; M - Medium; L – Low

Course	Core Course VIII	Code	B2PZOC8P

LABORATORY COURSE II:
CELL BIOLOGY, DEVELOPMENTAL BIOLOGY, ENVIRONMENTAL BIOLOGY

Credits	6	Semester	II	Hours/Week	6

Marks	CIA	40	Ext	60	Total	100

Course Objectives:

The main objectives of this course is:

Practical course aims at demonstrating significant cellular and molecular biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology, developmental biology and environmental biology into practical understanding.

Pre-requisite:

Students should have acquired basic knowledge relevant to this particular lab course.

Expected Course Outcome:

Upon completion of this lab course, students

LO1	Acquire knowledge to differentiate the cells of various living organisms and become aware of physiological processes of cells e.g. cell divisions, various stages of fertilization and embryo development.	**K2**
LO 2	Understand and observe as well as correctly identify different cell types, cellular structures using different microscopic techniques.	**K3**
LO 3	Develop handling - skills through the wet-lab course.	**K6**
LO 4	Learn the method of culturing of *Drosophila* and identification of their wild and mutant strains	**K1 K2**
LO 5	Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities	**K1 K2**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

CELL AND MOLECULAR BIOLOGY

1. Determination of cell size using micrometre
2. Mitosis in root meristematic cells of plants
3. Identification of various stages of meiosis in the testes of grasshopper
4. Detection of polytene chromosome in salivary gland cells of the larvae of the Chironomus
5. Detection of sex chromatin
6. Identification of blood cells in the haemolymph of the of the cockroach

DEVELOPMENTAL BIOLOGY

1. Observation and whole mount preparation of the chick blastoderm - 18 hours of development
2. Chick embryonic stage - 24 hours of development
3. Chick embryonic stage - 48 hours of development
4. Chick embryonic stage - 72 hours of development
5. Chick embryonic stage - 96 hours of development

6. Histological observation: Section through various developmental stages in chick embryo
7. Observation of mammalian sperm (bull)

ENVIRONMENTAL BIOLOGY

1. Estimation of water quality parameters a) dissolved oxygen b) BOD c) carbon dioxide d) salinity e) pH
2. Identification of freshwater and marine plankton;

Spotters - Secchi Disc, colorimeter, pH meter, thermometer, BOD incubator.

Field visit: Biological parks, Zoo, Museum.

Laboratory Manual

- ✓ Chaitanya, K. V. 2013. Cell And Molecular Biology: A Laboratory Manual Pages: 156. Phi Learning. Print Book ISBN: 9788120348004
- ✓ David Ng. 2022. Molecular Biology Laboratory Manual 2022. P56.
- ✓ Jyoti Saxena, Mamta Baunthiyal & Indu Ravi. 2024. Laboratory Manual of Microbiology, Biochemistry and Molecular Biology. ISBN 9788172337667. 380
- ✓ Ashok Ahuja. 2020. Practical Manual on Techniques in Molecular Biology. RVSKVV Gwalior.
- ✓ Laura R. Keller, John Hyde Evans, Thomas C. S. Keller. 1999. Experimental Developmental Biology: A Laboratory Manual. Academic Press. Pp 114.
- ✓ M.M. Trigunayat & Kritika Trigunayat. 2019. A Manual of Practical Zoology: Biodiversity, Cell Biology, Genetics & Developmental Biology Part 1. Scientific Publishers, India. ISBN 9789388449076.
- ✓ Mary S. Tyler. 2000. Developmental Biology, A Guide for Experimental Study, Second Edition, Sinauer Associates, Inc. Pp 206

Mapping with Programme Outcomes*										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	S	S	S	S	L	L	M
CO2	S	S	S	S	S	M	M	M	M	M
CO3	S	S	M	S	S	L	S	M	L	M
CO4	M	M	L	M	L	M	M	S	M	L
CO5	S	S	M	L	S	M	L	S	S	S

*S - Strong; M - Medium; L – Low

Course	Core Course IX	Code	B3PZOC9
GENETICS			

Credits	6	Semester	III	Hours/Week	6
Marks	CIA	30	Ext	70	Total	100

Course Learning Objectives:

The main learning objectives of this course are:

LO1	Understanding DNA as genetic material, fine structure of DNA & RNA molecules, as well as physico-chemical properties of macromolecules.
LO2	Gain insight into sequential events occurs during protein synthesis.
LO3	Learn the structure and function of chromosome and chromosomal basis of genetic disorders.
LO4	To acquire knowledge about microbial genetics
LO5	To provide information about rDNA technology and its application.

Pre-requisite:

Basic knowledge on molecular biology and genetics

Unit I	Introduction to Genetics: Mendel and his experiments, Mendel's laws of inheritance. Interaction of genes: Allelic and nonallelic interaction, Complementary genes, epistasis, pleotropism. Polygenic action: skin colour in man -Multiple alleles: ABO blood group system, Rh group and its inheritance.
Unit II	Linkage and Crossing, Complete & Incomplete Linkage, Measuring Recombination frequency and linkage map construction using three factor crosses, Interference and coincidence Sex linkage in Drosophila (White eye locus) & Human (Haemophilia)
Unit III	Mutation: Types of gene mutations, chromosomal aberrations (Classification with one suitable example from Drosophila and Human), Variation in chromosome number; Nondisjunction of X chromosome in Drosophila; Non-disjunction of Human Chromosome 21. Molecular basis of mutations in relation to UV light and chemical mutagens. Mutation detection in Drosophila by attached X method. Biochemical mutation detection in Neurospora.
Unit IV	Recombinant DNA technology: Recombinant DNA technology - Overview - Tools for Recombinant DNA Technology-Vectors: types. Techniques used in recombinant DNA technology. generation of DNA fragments - Restriction endonucleases, DNA modifying enzymes, Ligases
Unit V	Introduction of rDNA into host cell - calcium chloride mediated gene transfer - *Agrobacterium* mediated DNA transfer, electroporation, microinjection, liposome fusion, particle gun bombardment - Selection and screening of transformed cells - Expression of cloned gene; Application of rDNA technology in human welfare - Environment, Medicine and Agriculture

Expected Course Outcome:

On the successful completion of the course, student will be able to

LO1	Explain the organization and functions of genetic material in the living system.	**K1 K2**
LO2	Understand various sequential processes in protein synthesis	**K1 K2**
LO3	Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.	**K2 K4**

LO4	Able to distinguish lytic and lysogenic cycle and explain the mechanisms of genetic recombination of the microbes.	**K2 K5**
LO5	Understand the principle and application of rDNA technology for the welfare of human being.	**K2 K3**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley & Sons. INC. New York, pp-740.

Brooker, R. J. 2014. Genetics: Analysis and Principles. 5th Edition, McGraw Hill Publsiher, pp-880.

Russell, P.J. 2005. Genetics: A Molecular Approach (2nd Edition). Pearson/Benjamin Cummings, San Francisco, pp-850.

https://onlinecourses.swayam2.ac.in/cec21_bt02/preview

https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/the-genetic-code

Recommended texts

1. Griffiths, A. J. F., H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart. 2012. An Introduction to Genetic Analysis. 11th Edition, W. H. Greeman. New York.
2. Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics, John Wiley Publications, pp-784.
3. Watson, J. D., T. A. Baker, S. P. Bell, Alexander Gann, Michael Levine, Richard Losick. 2003. Molecular Biology of the Gene, (5th Edition). Cold Spring Harbor Laboratory Press, pp-912.
4. Klug, W. S. and M. R. Cummings, C. A. Spencer. 2005. Concepts of Genetics, Benjamin - Cummings Publishing Company.

Mapping with Programme Outcomes*										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	L	L	S	S	S	L	M	S
CO2	S	M	M	M	S	M	M	M	L	S
CO3	M	S	L	L	M	S	M	L	S	L
CO4	S	M	S	M	M	S	S	S	S	S
CO5	S	S	S	M	E	S	M	S	M	M

*S - Strong; M - Medium; L – Low

Course	Core Course X	Code	B3PZOC10
ANIMAL PHYSIOLOGY			
Credits	6	Semester	III
Hours/Week	6		

Marks	CIA	30	Ext	70	Total	100

Course Objectives:

The main objectives of this course are:

LO1	To analyze the functional mechanisms of digestive, circulatory, respiratory, renal, and neuro-endocrine systems that sustain homeostasis in animals.
LO2	To investigate the ionic and molecular basis of resting membrane potentials, action potential kinetics, synaptic transmission, and sensory transduction across tactile, visual, and auditory pathways.
LO3	To evaluate the neural, hormonal, and chemical feedback networks governing blood pressure, blood volume, acid-base equilibrium, electrolyte balance, and human reproductive pathways.
LO4	To compare respiratory, excretory, and circulatory structural adaptations across diverse animal groups to understand evolutionary strategies in physiological functioning.
LO5	To assess the physical, chemical, and neuroendocrine mechanisms underlying thermoregulation, acclimatization, and physiological adaptation in organisms exposed to extreme environmental conditions.

Pre-requisite:

Students should know the fundamentals of structure and functions of organs and organ systems of animals.

Unit I	Digestive system: Digestion, absorption, energy balance, BMR. Excretory system: Comparative physiology of excretion, human kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance
Unit II	Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, haemostasis. Cardiovascular system: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG-principle and significance. cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above
Unit III	Respiratory system: Comparison of respiration in different species, human anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration
Unit IV	Nervous system: Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Sense organs: Vision, hearing and tactile response
Unit V	Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases) Human reproduction: reproductive processes, gametogenesis, ovulation, neuroendocrine regulation. Thermoregulation: Comfort zone, body temperature- physical, chemical, neural regulation, acclimatization: Stress and adaptation

Expected Course Outcome:

On the successful completion of the course, student will be able to

LO1	Understand the functions of different systems of animals	K1
LO2	Learn the comparative anatomy of heart structure and functions	K2

LO3	Know the transport and exchange of gases, neural and chemical regulation of respiration	K2 K4
LO4	Acquire knowledge on the organization and structure of central and peripheral nervous systems	K3 K5
LO5	Understand and appreciate the endocrine function	K3 K5

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

Reading list

1. Prosser C. L. 1991, Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley-Liss Publishers, pp-592
2. Hoar, S.W. 1983, General and Comparative Physiology, Prentice Hall Publication, pp-928.
3. Randall, D., W. Burggren, K. French and R. Eckert. 2001, Animal Physiology Mechanisms and Adaptations, New York: W.H. Freeman and Co., pp-
4. Nelson K. S. 1997. Animal Physiology: Adaptation and Environment, Cambridge University Press, pp- 617.
5. Dantzler, W.H. 1997. Comparative Physiology (Handbook of Physiology), Volumes I and II. Edited by William H. Dantzler. pp - 1824 Published for the American Physiological Society by Oxford University Press Inc., New York. Oxford University Press Canada, Toronto.

Recommended texts

1. Shepherd, G. M. 1994. Neurobiology, OUP USA Publsiher, pp-774.
2. Hainsworth, F.R. 1981. Animal Physilogy: Adaptation in function, Addison Wesley Longman Publishers, pp-669.
3. Mcfarland, D. 1999. Animal Behaviour: Psychobiology, Ethology and Evolution, Longman Publisher, pp-592.
4. Gorden, M.S. *et al.,* 1977. Animal Physiology: Principles and Adaptation, New York, Third Edition.
5. Ahearn, G.A. *et al*., 1988. Advances in Comparative and Environmental Physiology – 2, Springer Publishers, pp-252.
6. Hill, R.W. 1976. Comparative Physiology of Animals: Environmental Approach, Longman Higher Education Publisher, pp-656.
7. Withers, P.C. 1992. Comparative Animal Physiology, Brooks/Cole Publisher, pp-900.

Mapping with Programme Outcomes*										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	S	M	S	M	L	S	M	S	S
CO2	S	S	M	S	S	S	S	M	S	S
CO3	S	M	S	S	S	M	L	S	M	S
CO4	S	S	S	S	S	L	M	S	S	M
CO5	S	S	S	M	M	M	M	L	L	M

*S - Strong; M - Medium; L – Low

Course	Core Course XI	Code	B3PZOC11P
Laboratory Course III: GENETICS, ANIMAL PHYSIOLOGY, RESEARCH METHODOLOGY AND EVOLUTION			

Credits	6	Semester	III	Hours/Week	6
Marks	CIA	40	Ext	60	Total	100

Course Objectives:

The main objectives of this course are:

To learn the laws of heredity with practical emphasis on inheritance

Exploration of the process of biological evolution and the fundamental mechanisms and concepts by which evolution works.

To give students competent lab skills in animal physiology

Pre-requisite:

Students should have acquired basic knowledge relevant to this particular lab course.

Expected Course Outcome:

Upon completion of this lab course, students are able to:

1	Learn to culture drosophila, the genetic model organism	K3
2	Know the chromosomal abnormalities and huma karyotyping	K1, K2
3	know the evidences of evolution, the fossils	K5
4	Understand the key physiological events of living organisms	K4 K5
5	Differentiate excretory products and their evolutionary pattern	K1, K2

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6** – Create

GENETICS

Drosophila-Culture, Mutants, Sex Identification; Blood groups: ABO and Rh-grouping; Human Karyotyping & Chromosomal Abnormalities; Hardy-Weinberg Law & Calculation of Gene frequencies for dominant, recessive and co-dominance traits and multiple alleles.

ANIMAL PHYSIOLOGY

Estimation of oxygen consumption in fish
Estimation of haemoglobin in human blood
Salt loss and salt gain in fish
Test for urea and sugar in urine sample
Quantitative estimation of amylase activity
Quantitative estimation of ammonia and urea
Spotters: BP apparatus, Stethoscope and ECG

RESEARCH METHODOLOGY

Index card preparation, Reference card preparation, Abstract writing,
Spotters: Phase contrast microscope, Centrifuge, Paper chromatography, PAGE, AGE

EVOLUTION

Study of fossils
Study of finger prints
Spotters – homologous and heterologous organs, vestigial organs, mimicry, colouration, living fossils.

Visit to Ecologically important sites, fossil beds, national parks, bird sanctuary, zoos, museum

Laboratory manual

1. Genetics: A Laboratory Manual. 2015. Gregore Koliantz, Daniel B. Szymanski. ISBN: 978-0-891-18562-8.
2. Genetics Laboratory Manual. 2022. Ernest Brown Babcock and Julius Lloyd Collins. Legare Street Press. Pp 70. ISBN 978-1016036887
3. Organic Evolution Laboratory Manual. J. Arthur Finger.
4. Laboratory Manual for Animal Physiology. 1983. Don W. Bailey. Tichenor Pub; 2nd edition (1 December 1983)
5. Research Methodology for Biological Sciences, 2011. Gurmani, N. MJP Publishers, Pp 753.

Mapping with Programme Outcomes*										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	S	S	S	S	S	L	L	M
CO2	S	S	S	S	S	M	M	M	M	M
CO3	S	S	M	S	S	L	S	M	L	M
CO4	M	M	L	M	L	M	M	S	M	L
CO5	S	S	M	L	S	M	L	S	S	S

Course	Core Course XII	Code	B3PZOC12
RESEARCH METHODOLOGY			

Credits	6	Semester	III	Hours/Week	6
Marks	CIA	30	Ext	70	Total	100

Course Objectives:

The main objectives of this course are

LO1	Introduce fundamental concepts of academic research, scholarly writing, publishing ethics, and plagiarism prevention.
LO 2	Train students in leveraging scientometrics, citation databases, digital libraries, and virtual lab platforms for literature reviews.
LO 3	Impart theoretical knowledge and technical competence in Good Laboratory Practice (GLP), spectroscopy, bio-instrumentation, and bioinformatics.
LO 4	Explain advanced principles of light, fluorescence, electron, and confocal microscopy applicable to biological specimens.
LO 5	Provide comprehensive understanding of analytical biochemistry techniques, radioisotope tracers, and animal cell culture protocols.

Pre-requisite:

Students should know the fundamentals of basic methods employed in experimental biology.

Unit I	Research: Definition-types-selection of problem. Research Report Preparation - Thesis Writing and MS preparation- Proof reading. Journals - types of journals - peer reviewed and non-peer reviewed, paid and unpaid journals - online journals- open access journals – Types and Format of Journal Articles - Short Communication - Review Articles - Research Papers –Plagiarism
Unit II	Bibliometrics and Scientometrics - Impact Factor – Science Citation Index – H-index-I10 index, Scopus - Information Retrieval: access to archives and databases (literature databases), Search Engines: Google Scholar, PubMed, Online database library, Digital Library and Virtual Labs
Unit III	Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry. Histology, Histochemistry, Bioinformatics and Electron microscopy
Unit IV	Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy
Unit V	Centrifuges, Chromatography, Electrophoresis, ELISA and blotting. Principles and Applications of tracer techniques in biology, Animal cell culture techniques.

Expected Course Outcome:

On the successful completion of the course, student will be able to

LO1	Understand the concept of research and research report writing	**K1**
LO2	Learn the quality and quantity indices of research	**K2**
LO3	Understand the implications of GLP, learn working principle of the instruments and gain knowledge on histological	**K2** **K4**
LO4	Acquire knowledge on the basic principle and application of various modules of light and electron microscopy	**K3** **K5**
LO5	Have knowledge on tracer technology and cell culture techniques	**K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6-** Create

Reading list

1. Pearse, A.G. 1968. Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J & A Churchill Ltd, pp-758.
2. Lillie, R.D. 1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.
3. Hoppert, M. 2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.

Recommended texts

1. Chandler, D.E. and Roberson R.W. 2009. Bioimaging: Current Concepts in Light and Electron Microscopy, Jones and Bartlet Publishers, Sudbury, MA, USA, pp440.
2. Engelbert, B. 1960. Radioactive Isotopes in Biochemistry, Elsevier Applied Science, pp-376.
3. Wolf, G. 1964. Isotopes in Biology, Academic Press, pp-173.
4. Srivastava, B. B. 2005. Fundamentals of Nuclear Physics, Rastogi Publications, pp-500.
5. Pantin, C. F. A. 1948. Microscopical Techniques, Cambridge University Press, London.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	M	S	M	S	M	M
CO2	S	S	M	S	S	S	M	M	M	S
CO3	S	M	S	S	S	S	S	S	S	L
CO4	S	S	S	S	S	M	S	S	S	M
CO5	S	S	S	M	M	S	M	L	S	M

*S - Strong; M - Medium; L-Low

Course	Core Course XIII	Code	B4PZOC13
IMMUNOLOGY			

Credits	6	Semester	IV	Hours/Week	6
Marks	CIA	30	Ext	70	Total	100

Course Learning Objectives:

The main objectives of this course are:

LO1	Provide a comprehensive foundation in the anatomical and physiological components of innate and adaptive immune systems.
LO2	Characterize antigenic properties, immunogens, and the role of adjuvants in enhancing immune responses.
LO3	Examine cellular immune mechanisms, including lymphocyte sub-populations, T-cell/B-cell receptors, antigen processing, and MHC-mediated presentation.
LO4	Detail the structure, diversity, and biological functions of antibodies, the complement cascade, cytokines, and hybridoma technology.
LO5	Analyze the etiology and immune mechanisms underlying hypersensitivity, autoimmunity, immunodeficiencies, infectious diseases, and modern vaccine design.

Pre-requisite:

Students would have basic knowledge in animal science, particularly functional anatomy, cell biology and developmental biology.

Unit I	Introduction to Immunology: An overview; Scope of immunology, recognition of self and non-self as a basic functional feature of immune system; Concepts of external and internal defence systems; External (first line / innate) defence system: components, distribution, salient functions; Internal (second line / acquired) immune system: cellular and humoral immune components- distribution, salient functions-primary and secondary immune responses; Immune tissues / organs: types, anatomical location, structure and development; lymphocyte traffic during development; Types of immunity: innate and acquired - types, functional features; concept of adaptive immunity
Unit II	Antigens: Definition, characteristic features and classification; Antigenicity versus immunogenicity; Adjuvants: definition, types and applications
Unit III	Major effector components of cellular immune system: Lymphocytes - types, morphology, clones; sub-populations, distribution, B and T cell receptors, B and T cell epitopes, Toll-like receptors; Antigen presenting cells: antigen processing and presentation, MHC molecules and their immunologic significance
Unit IV	Major effector components of humoral immune system: Antibodies - Primary structure, classification, variants and antigen-antibody interactions; Structural and functional characteristics of various antibody classes; Generation of diversity; Monoclonal antibodies: definition, production and applications; Antibody engineering and its applications. Complement system - Components, three major activation pathways, and immune functions including anaphylaxis and inflammation. Cytokines - Definition and salient functional features; Interleukins: definition, types (lymphokines and monokines), and functions. Interferons - Origin, types and functions
Unit V	Diseases and immune responses: Hypersensitivity: definition, Types I to IV and immune manifestations; Auto-immune diseases: onset, spectrum of diseases, and major immune responses; Immunodeficiency diseases: types including SCID and

	consequences; Viral (HIV), bacterial (tuberculosis) and parasitic (malaria) diseases: etiology, host immune responses and evasion by pathogens; Vaccines: types, preparations, efficacies and recent developments	
Expected Course Outcome:		
Students would have acquired clear knowledge on		
LO1	Various basic concepts in immunology and organization of immune systems.	K2
LO2	Mechanisms of immune response in health and their defects in various diseases.	K2 K4
LO3	The application of immunological principles in biomedical sciences including blood transfusion, tissue grafting and organ transplantation.	K3 K5
LO4	Vaccinology and its importance in disease management	K3
LO5	Autoimmune, immunodeficiency, and other infectious diseases	K2
K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create		

Reading list

1. Kuby, J. 1997. Immunology. W. H. Freeman & Co., New York, pp-670.
2. Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7th edition), Mosby / Elsevier, Philadelphia, pp-472
3. Abbas, A. K and A. H. Lichtman. 2007. Cellular and Molecular Immunology (6th edition), W. B. Saunders, Philadelphia, pp-564
4. Coica, R. Sunshine, G. 2015. Immunology (Seventh Edition), Wiley Blackwell, UK, pp-406.

Recommended texts

1. Weir, D. M and J. Stewart. 1997. Immunology, Churchill Livingstone, London, pp-362
2. Peakman, M and D. Vergani. 1997. Basic and Clinical Immunology, Churchill Livingstone, London, pp-366
3. Parham, P. 2009. The Immune System. Garland Science, USA, Pp-506
4. Weissman, I. Hood, L. Wood, W. 1978. Essential Concepts in Immunology, the Benjamin/Cummings, California, pp-165.
5. Hood, L. Weissman, I. Wood, W. Wilson, J. 1984. Immunology. The Benjamin/Cummings, California, pp-558.
6. Doan, T. Melvold, R. Viselli, S. 2013. Immunology. Lippincott Williams & Wilkins, Maryland, pp-376.
7. Owen, J. A. Punt, J. Stanford, S. A. 2013. Kuby Immunology. Macmillan, England, pp-692.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	S	S	S	S	M	S	S	S
CO2	S	S	M	S	S	S	M	M	S	S
CO3	S	M	M	S	S	S	S	S	S	M
CO4	M	S	M	M	S	S	S	S	S	M
CO5	M	S	S	S	M	S	M	S	S	M

*S - Strong; M - Medium; L – Low

Course	Core Course XIV	Code	B4PZOC14P
LABORATORY COURSE IV: IMMUNOLOGY*			

Credits	6	Semester	I	Hours/Week	6

Marks	CIA	40	Ext	60	Total	100

Course Objectives:

The main objectives of this course are:

1	To provide hands-on training to perform specific lab courses in immunology and research methodology.
2	To enable clear understanding of the methodology through wet – lab courses.

Pre-requisite:

Students should acquire the basic knowledge relevant to a particular lab course

Expected Course Outcome:

Upon completion of this lab course, the students

1	Acquire ability to perform/ demonstrate various basic concepts in immunology	K3
2	Develop skill in applications of research methods for quantitative/ qualitative analysis of biochemical components.	K2
3	Identify the different types of immune organs	K3
4	Do basic immunological experiments	K5
5	Have knowledge on advanced techniques in immunology	K4

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create
*includes elective course

Immunology

1. Identification of various immune tissues and organs in rat
2. Identification of various types of immune cells in peripheral blood smear
3. Agglutination reaction: Qualitative analysis of antigen-antibody reaction using human blood group system
4. Agglutination reactions: Determination of hemagglutination titer of IgM antibodies using human RBC
5. Detection of IgG by precipitation ring test
6. Detection of IgG by Ouchterlony double immuno-diffusion test.
7. Separation of lymphocytes from peripheral blood and identification of T and B cells
8. Concentration of antigen by radial immunodiffusion method.

Spotter: Immune tissues and organs

Aquaculture

1. Estimation of Biochemical Oxygen Demand.
2. Estimation of soil pH using soil pH meter.
3. Estimation of pH in pond water using pH meter.
4. Identification of zooplankton of pond/seawater.
5. Demonstration of Artemia culture.

Spotter: Secchi disc, thermometer, water sampler, pH pen, soil pH meter, catla, rohu, mrigal, tilapia.

Educational Tour:

Visit to vaccine production units, aquaculture research institutes, fish and shrimp ponds and hatcheries, fish processing plants.

Elective Courses

Course	**Elective Course I**	**Code**	**BPZOECA**
BIOSTATISTICS			
Credits	**6**	**Hours/Week**	**6**

Marks	CIA	30	Ext	70	Total	100

Course Objectives:

The main objectives of this course are:

LO1	To define key biostatistical concepts, classify biological data types, and determine appropriate methods for primary data collection, frequency distribution, and graphical visualization using software tools (SPSS, R, or PAST).
LO2	To calculate and interpret measures of central tendency, dispersion, standard error, and coefficients of variation to quantify biological variability across populations and sample groups.
LO3	To evaluate biological phenomena (e.g., genetic ratios, species distribution, normal physiological variations) using Binomial, Poisson, and Normal probability distributions and z-score transformations.
LO4	To formulate null and alternative hypotheses, assess Type I and Type II errors, and execute Chi-Square tests, Student's t-tests, and correlation analyses (Pearson and Spearman) to deduce statistical significance in ecological and experimental data.
LO5	To construct linear regression models for biological variable prediction and design multi-group experiments using One-way and Two-way Analysis of Variance (ANOVA) to derive data-driven scientific conclusions.

Pre-requisite:

Students should be aware of importance of analysis of quantitative and qualitative information from biological studies.

Unit I	**Data Collection, Organization, and Visualization in Biology** **Overview:** Definition, scope, and applications of biostatistics in zoological and biological research. **Data & Variables:** Primary vs. secondary data (sources, reliability, and ethics). Biological variables: discrete, continuous, nominal, and ordinal. **Data Structuring:** Principles of classification, tabulation, and frequency distribution for grouped and ungrouped biological data. **Graphical Representation:** Construction and interpretation of histograms, frequency polygons, ogive curves, bar diagrams, pie charts, and biological pictograms.
Unit II	**Descriptive Statistics: Central Tendency and Dispersion** **Central Tendency:** Concepts, mathematical formulations, and biological applications of Mean, Median, and Mode for continuous and discrete datasets. **Measures of Dispersion:** Range, variance, standard deviation, and standard error of mean (SEM); Coefficient of Variation (CV) for comparing biological variability across samples.
Unit III	**Probability Theory:** Definitions, sample space, events, classical and empirical probability; Addition and Multiplication theorems. **Probability Distributions:** Properties, probability density functions, and biological applications of Binomial, Poisson, and Normal distributions. Standard Normal distribution (Z-score) and its significance in hypothesis testing.

Unit IV	**Hypothesis Testing:** Formulation of Null (H_0) and Alternative (H_1) hypotheses; Type I and Type II errors; Level of significance (α) and p-value concepts. **Parametric & Non-Parametric Tests:** **Chi-Square (χ^2) Test:** Test of goodness-of-fit and independence of attributes in genetic/ecological ratio analysis. **Student's t-test:** One-sample t-test, independent two-sample t-test, and paired-sample t-test for biological mean comparisons. **Correlation Analysis:** Pearson's product-moment correlation coefficient (r), Spearman's rank correlation coefficient (ρ), testing significance of correlation coefficients.	
Unit V	**Regression Analysis:** Simple linear regression, computation of regression coefficients (a and b), line of best fit, prediction of biological variables, and coefficient of determination (R^2). **Analysis of Variance (ANOVA):** Principles of experimental design; One-way and Two-way ANOVA for comparing multiple biological treatment groups. **Statistical Computing:** Data entry, descriptive data analysis, parametric/non-parametric testing, and graphical output generation using SPSS / R / Past software.	
Expected Course Outcome:		
Upon completion of this course, Students would have		
LO1	Clear understanding of design and application of biostatistics relevant to experimental and population studies.	**K2** **K3**
LO2	Have an idea about data, data types and data collection methods	**K3** **K4**
LO3	Knowledge on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate statistical design/ methods of analysis.	**K5** **K6**
LO4	Able to analysis biological data using different types of statistical tests	**K4**
LO5	Acquired skills to perform various statistical analyses using modern statistical techniques and software	**K5**
K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create		
Reading list		
Arora, P. N. and P. K. Malhan. 2010. Biostatistics, Himalaya Publishing House, Mumbai, pp-447. Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp-407. Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp-363. Palanichamy, S. and Manoharan, M. 1990. Statistical Methods for Biologists, Palani Paramount Publications, Tamil Nadu, pp-264.		
Recommended texts		
1. Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp-48. 2. Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467. 3. Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp-859.		

4. Zar, J.H. 2014. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660.
5. Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.
6. Wayne W. Daniel. Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons Inc, USA, pp-443.
7. Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp-593.
8. Pagano, M. and K. Gauvreau. 2008. Principles of Biostatistics (Second Edition), Cengage Learning, New Delhi, pp-525.

Mapping with Programme Outcomes*

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	L	M	S	S	M	S	M	M
CO2	S	S	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	S	S	S	S	L
CO4	M	M	S	L	M	M	M	S	L	M
CO5	M	M	S	L	M	S	M	L	S	M

*S - Strong; M - Medium; L- Low

Course	Elective Course II	Code	BPZOECB
POULTRY FARMING			
Credits	**6**	**Hours/Week**	**6**

Marks	CIA	30	Ext	70	Total	100

Course Objectives:

The main objectives of this course are:

LO1	To trace the historic evolution and modern status of the Indian poultry industry, while categorizing diverse housing systems, structural designs, and environmental management principles suited for commercial production.
LO2	To apply flock management protocols across distinct growth stages (chicks, growers, layers, and broilers) and construct viable project reports for banking, insurance, and entrepreneurial ventures.
LO3	To analyze the nutrient requirements of layers and broilers across varying life stages and formulate balanced, cost-effective feed rations using standard feeding methods.
LO4	To diagnose symptoms of major viral, bacterial, fungal, and parasitic poultry diseases and design biosecure farm management practices alongside comprehensive vaccination schedules.
LO5	To assess protocols for hatching egg selection, incubation, chick sexing, and brooding, while synthesizing strategies for farm sanitation, water hygiene, and waste recycling.

Pre-requisite:

Students should be aware of economic and cultural importance of Poultry farming.

Unit I	General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming
Unit II	Management of chicks - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance.
Unit III	Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.
Unit IV	Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.
Unit V	Selection, care and handling of hatching eggs - Egg testing. Methods of hatching. - Brooding and rearing -. Sexing of chicks. - Farm and Water Hygiene - Recycling of poultry waste.

Expected Course Outcome:

Upon completion of this course, students are able to:

LO1	know the development of poultry farming in India and system	**K1**
LO2	understand the various practices in Poultry farming. To know the needs for Poultry farming and the status of India in global market.	**K2** **K3**
LO3	apply the techniques and practices needed or Poultry farming.	**K4** **K5**
LO4	identify the disease of poultry and treat them	**K4**
LO5	Mange the poultry industry in different season	**K4** **K5**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write & Print Publications, New Delhi

Jull A. Morley, 2007. Successful Poultry Management. 2nd Edition. Biotech Books, New Delhi"

Hurd M. Louis, 2003. Modern Poultry Farming. 1st Edition. International Book Distributing Company, Lucknow.

Recommended texts

1. http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf
2.https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf
3. http://ecoursesonline.iasri.res.in/course/view.php?id=335
5. https://swayam.gov.in/nd2_nou19_ag09/preview

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	L	L	L	L	L	S	S	L	L
CO2	S	L	M	M	S	M	M	M	S	S
CO3	S	M	M	M	S	S	S	S	M	M
CO4	S	S	S	L	S	S	S	S	S	S
CO5	S	S	M	S	S	S	M	L	S	M

*S - Strong; M - Medium; L – Low

Course	Elective Course III	Code	BPZOECC
EVOLUTION			
Credits	6	Hours/Week	6

Marks	CIA	30	Ext	70	Total	100

Course Learning Objectives:

The main objectives of this course are to appreciate

LO1	the concepts of evolution
LO2	the factors responsible for origin and generation of diversity among living beings
LO3	Major events in evolutionary time scale
LO4	Factors influencing population genetics
LO5	the use of molecular tools in studying the evolutionary process

Pre-requisite:

Students shall have basic knowledge on the diversity of animals, biology including morphological, anatomical, physiological and embryological features of various phyla and their environment.

Unit I	Concept and theories of evolution: History of evolutionary thoughts – Lamarckism – Neo-Lamarckism – Darwinism – Neo-Darwinism – Mutation theory of De Vries – Modern synthetic theory of evolution.
Unit II	Origin of biological molecules and first cell: Abiotic synthesis of organic monomers and polymers. Miller-Urey Experiment–coacervation – formation of protocell and first cell – evolution of anaerobic and aerobic metabolisms. Origin of Prokaryotes and Eukaryotes
Unit III	Evidences of evolution: morphological evidences – embryological evidences – geographical evidences – physiological evidences – taxonomical evidences – genetical evidences – palaeontological evidences.
Unit IV	Molecular evolutionary tools and evolutionary history: protein and nucleotide sequence analysis tools and their applications – phylogenetic analysis tools – evolutionary time scale and major events – fossil evidences for human evolution.
Unit V	Population genetics and patterns of evolution: gene pool and gene frequency - Hardy-Weinberg Law and evolution - adaptive radiation - convergent evolution - co-evolution - speciation.

Expected Course Outcome:

On the successful completion of the course, student will be able to

LO1	Understand the concept of evolution. It provides a comprehensive account of evidences to support concept of evolution and different theories for exploring the mechanism of evolution.	**K1 K3**
LO2	Appreciate origin of first cell, organic molecules, experiment to proof abiogenesis, evolution of aerobic and anaerobic metabolism.	**K1 K2**
LO3	Understand evidences of evolution.	**K2 K3**
LO4	Comprehend molecular evolutionary tools and evolutionary history	**K2 K4**
LO5	Appreciate population genetics and patterns of evolution	**K4 K5**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

Bergstrom, C. T. and L. A. Dugatkin. 2012. Evolution, Second MEDIA Edition. W.W. Norton & Company, International Student Edition, pp-756.
Jobling, M., E. Hollox, M. Hurles, T. Kivisild and C. T. Tyler Smith. 2014. Human Evolutionary Genetics. Second Edition. Garland Sciences, London, pp-650.
Veer Bala Rostogi, 2018. Organic Evolution (Evolutionary Biology), Thirteenth Edition Vinoth Kumar Jain, Scientific International (Pvt.) Ltd, New Delhi, pp-590.
https://www.flipkart.com/books/evolution~contributor/pr?sid=bks
http://www.evolution-textbook.org/
https://onlinelibrary.wiley.com/journal/15585646
http://darwin-online.org.uk/

Recommended texts

Strickberger. M. W. 2000. Evolution. Third Edition, Jones Bartlett Publishers, pp-722.
Hall B. K. and B. Hallgrimsson. 2014. Strickberger's Evolution. Fifth Edition, Bartlett Learning, An Ascend Learning Company, pp-642.
Barton, N.H., D. Briggs, J.A. Eisen David, D.B. Goldstein and N.H. Patel. 2007. Evolution. Cold Spring Harbor Laboratory Press, pp-833.

Mapping with Programme Outcomes*										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	S	M	S	M	L	S	M	L	M
CO2	S	S	L	S	S	L	S	S	S	S
CO3	S	M	S	S	S	S	S	L	L	M
CO4	S	S	S	S	S	M	S	S	S	L
CO5	S	S	S	M	M	S	S	L	L	M

*S - Strong; M - Medium; L - Low

Course	Elective Course IV	Code	BPZOECD
MEDICAL LABORATORY TECHNIQUES			

Credits	6			Hours/Week	6	
Marks	CIA	30	Ext	70	Total	100

Pre-requisite:

Students should have a basic knowledge about medical laboratories and the works carried out by them.

Course Objectives:

The main objectives of this course are:

LO1	To explain the principles of Good Laboratory Practices (GLP), biosafety levels (BSL), and biomedical waste management, while evaluating the physiological impacts of lifestyle habits (alcohol, tobacco, junk food) on human health.
LO2	To execute standard blood collection techniques, analyze hemopoiesis, perform routine hematological assays (Hb, ESR, PCV, total/differential counts, platelet count), and evaluate coagulation disorders alongside hemolytic diseases.
LO3	To examine the operational principles, clinical applications, and diagnostic significance of modern imaging and diagnostic tools, including CT scans, MRI, PET scans, Flow Cytometry, and Treadmill Tests.
LO4	To analyze the physiological regulation of blood pressure, pulse, and heart rate, while interpreting clinical diagnostic outputs such as Electrocardiograms (ECG), Electroencephalograms (EEG), and Ultrasonography.
LO5	To execute tissue processing, paraffin embedding, microtomy, standard and vital staining, and mounting protocols, while troubleshooting sectioning artifacts and applying frozen section techniques for histological analysis.

Unit I	Laboratory safety: toxic chemicals and biohazards waste. Biosafety level. Good Laboratory Practices. Hygiene and health issue: physiological effect of alcohol, tobacco, smoking, junk food & its treatment. Biomedical waste management.
Unit II	Collection of blood & lab procedure-haemopoiesis. Mechanism of blood coagulation: bleeding time, clotting time, determination of hemoglobin, erythrocyte sedimentation rate, packed cell volume (PCV), total count of RBC & WBC, Differential count (DC), blood grouping and typing. Haemostasis-bleeding disorder of man. Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.
Unit III	Computer tomography (CT-Scan), Magnetic Resonance imaging, Flowcytometry, Treadmill test, Positron Emission Tomography (PET)
Unit IV	Blood pressure, Pulse regulation, Heart rate, Cardiac shock. Heart sounds, Electrocardiogram (ECG), significance, ultra sonography, Electroencephalography (EEG).
Unit V	Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtomes- sectioning, staining - staining methods - vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.

Expected Course Outcome:

Upon completion of this course, Students would have

LO1	acquire knowledge in clinical laboratory science and general education subjects	**K1 K2**

LO2	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.	**K3**
LO3	Explain the characteristics of clinical samples and demonstrate skill in handling clinical equipment.	**K3** **K4**
LO4	Evaluate the hematological and histological parameters of biological samples	**K3** **K4**
LO5	Adapt to develop expertise in new techniques	**K5**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai.
2. Hall, 2011. Guyton and Hall Textbook of Medical Physiology, 12th edition, Elsevier, New Delhi.
3. Mukerjee, K.L, 2017. Medical Laboratory Technology- Vol, I, II, III. Tata MC Graw Hill, New Delhi. 3rd Edition
4. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation. Jaypee Brothers Medical Publishers (P) Ltd.; 6th edition. Pp. 1696.

Recommended texts

1. Manoharan, A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeypee brothers, New Delhi.
2. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia. Published by Tata McGraw-Hill Education Pvt. Ltd.,
3. Ochei. J., A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	M	M	M	L	L	M	M	L	M
CO2	S	S	M	S	S	S	L	M	S	S
CO3	M	S	S	S	S	S	S	S	S	L
CO4	S	S	M	M	L	M	L	M	M	S
CO5	M	M	S	S	M	S	L	L	S	S

*S - Strong; M - Medium; L-Low

Skill Enhancement Courses

Course	Skill Enhancement Course 1	Code	BPZOSE1A
AQUACULTURE			
Credits	6	Semester IV	Hours/Week 6
Marks	CIA 30	Ext 70	Total 100

Pre-requisite:

Students should know the fin fishes and shell fishes of commercially important candidate species.

The main objectives of this course are the learner should know basic concepts in Aquaculture and to

LO1	Impart foundational knowledge on the scope and types of aquaculture in India, including site selection, structural design, construction criteria, and water quality parameters essential for fish farm management.
LO 2	Train students in the principles and practices of fish seed procurement, natural and induced breeding mechanisms, seed transportation, and the formulation, preparation, and management of artificial and live feeds (Artemia and microalgae).
LO 3	Provide technical expertise in shell fish hatchery dynamics, extensive to intensive shrimp culture operations, biofloc systems, edible/pearl oyster farming, and seaweed cultivation alongside harvest and post-harvest management.
LO 4	Equip students with diagnostic, preventive, and therapeutic skills to manage infectious and non-infectious fish diseases, alongside the processing and preparation of value-added fish products.
LO 5	Develop skills in identifying, breeding, setting up, and maintaining freshwater and marine ornamental fish aquaria, while introducing the mandates and organizational roles of premier Indian national fisheries institutes (CMFRI, CIFRI, CIBA, CIFT, CIFA, CIFE, and MPEDA).

Units	Contents
I	**Overview & Scope:** Scope and significance of aquaculture; Present status of aquaculture production in India. **Aquaculture Systems:** Classification based on salinity (freshwater, brackish water, mariculture), culture intensity (extensive, semi-intensive, intensive, super-intensive), and operational design (monoculture, polyculture, composite fish culture, RAS, and IMTA). **Pond Design & Construction:** Criteria for site selection; Engineering designs of nursery, rearing, and stocking ponds; bunds, dykes, sluice gates, and drainage systems. **Water Quality Management:** Physical parameters (temperature, turbidity, depth); chemical parameters (pH, dissolved oxygen, alkalinity, hardness, ammonia, nitrites, nitrates, hydrogen sulfide). Aeration systems, liming, fertilization (organic and inorganic), and bioremediation.
II	**Reproductive Technology:** Collection of wild seed; Bundh breeding; Hypophysation/Induced breeding of fish, synthetic hormones (Ovaprim, Ovatide, GnRH analogs), broodstock management, stripping. **Fish Nutrition & Feed Technology:** Nutritional requirements of fish (proteins, lipids, carbohydrates, vitamins, minerals). Types of feeds (mash, floating, sinking

	pellets); feed formulation (Pearson square method), FCR calculation and feeding strategies. **Live Feed Culture:** Role of live food organisms in larval rearing; Isolation, mass culture, and nutritional enrichment protocols for microalgae, rotifers, and *Artemia*
III	**Shrimp Hatchery & Culture Technology:** Hatchery layout, broodstock maturation, ablation, spawning, larval stages (nauplius, zoea, mysis, post-larva), seed packing, and transportation. Culture systems for *Litopenaeus vannamei* (extensive to super-intensive); water exchange, feed management, and harvesting protocols. **Biofloc Technology (BFT):** Principle of $C:N$ ratio manipulation, biofloc formation, microbial community dynamics, advantages, and management in zero-water exchange systems. **Molluscan Culture:** Culture of edible oysters (*Crassostrea* spp.) and Pearl oyster (*Pinctada* spp.). **Seaweed Cultivation:** Culture of *Kappaphycus*, *Gracilaria*, *Sargassum* using monoline, raft, net methods; extraction and industrial applications of agar, alginate, and carrageenan.
IV	**Infectious Fish Diseases:** Bacterial (AER, Columnaris, Vibriosis); Fungal (Saprolegniasis, EUS); Viral (WSSV, IHHNV, TiLV); Protozoan (*Ichthyophthirius*, *Trichodina*) and metazoan parasites (*Lernaea*, *Argulus*). **Non-Infectious Fish Diseases:** Nutritional deficiencies, environmental stress, gas bubble disease, and asphyxiation.
V	**Ornamental Fish Diversity & Breeding:** Major freshwater (Guppy, Molly, Goldfish, Angel, Gourami, Discus) and marine (Clownfish, Damselfish) species; breeding behaviors, parental care, and egg/larval management. **Research Institutes:** ICAR-CIFA, ICAR-CMFRI, ICAR-CIFRI, ICAR-CIBA, ICAR-CIFT, ICAR-CIFE. **Promotional & Developmental Bodies:** MPEDA (Marine Products Export Development Authority), NFDB (National Fisheries Development Board), and Coastal Aquaculture Authority (CAA).
Upon completion of this course, Students would	
1	Know the status of fisheries and aquaculture in India and management of fish farms
2	Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques
3	Apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval culture
4	Identify different fish diseases, their management strategies and value-added fish products.
5	Understand Ornamental fish and central aquaculture organizations
Reading list	
Pillay, T. V. R. (1990). Aquaculture: Principles and Practices. Blackwell Scientific Publications Ltd. Santhanam, R. (1990). Fisheries Science. Daya Publishing House. Sinha, V.R. P. and Srinivastava, H. C. (1991). Aquaculture Productivity. Oxford and IBH Publications CO., Ltd., New Delhi. Yadav, B. N. (1997). Fish and fisheries. Daya Publishing house, New Delhi.	
Recommended texts	

Das M. C. and Patnaik, P. N. (1994) Brackish water culture. Palani paramount Publications, Palani, T. N.
Day, F (1958). Fishes of India, Vol I and Vol. II. William Sawson and Sons Ltd., London.
Jhingran, V. G. (1991). Fish and Fisheries of India. Hindustan Publishing Co., India
Maheswari. K. (1983) Common fish disease and their control. Institute of Fisheries Education, Powarkads (M.P).

Mapping with Programme Outcomes*										
Cos	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	S	M	M	S	S	S	M	M	S
CO2	S	S	S	M	S	S	S	M	S	S
CO3	S	S	S	S	S	S	S	S	S	M
CO4	S	S	M	S	S	S	S	M	M	S
CO5	S	S0	M	S0	M	S	M	L	S	S

*S-Strong; M-Medium; L-Low

Course	Skill Enhancement Course 2	Code	BPZOSE1B
SERICULTURE			

Credits	6	Semester IV	Hours/Week	6
Marks	CIA 30	Ext 70	Total	100

Course Objectives:

1	Provide a foundational understanding of natural textile fibers, non-mulberry silks, and the economic status of sericulture in India.	**K2** **K3**
2	Train students in mulberry agronomy, propagation methods, and crop protection strategies against diseases and pests.	**K1** **K2**
3	Detail the anatomical systems, reproductive biology, genetics, and diapause management of Bombyx mori.	**K5** **K6**
4	Impart technical knowledge of silkworm rearing equipment, environmental management, rearing methods, and disease/pest control protocols.	**K3** **K4**
5	Explain post-cocoon technology, silk reeling mechanics, quality testing parameters, and value addition using sericulture by-products.	**K5**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Units	
I	**Sericulture Industry:** History, socio-economic importance, employment generation, national status, and developmental role of Central Silk Board (CSB) and state agencies in India. **Sericigenous Insects:** Types of silk—Mulberry (*Bombyx mori*) and Non-Mulberry / Vanya silks (Tasar, Muga, Eri, Anaphe, Gonometa, Fagara, Spider, and Mussel silk). **Silk Properties:** Physical, chemical, and structural properties of sericin and fibroin.
II	**Mulberry Biology:** Distribution, taxonomy, floral and leaf morphology, and elite cultivars (*Morus* spp.). **Propagation Techniques:** Sexual (seeds) and asexual methods (stem cuttings, grafting, layering, and micropropagation/tissue culture). **Agronomic Practices:** Land preparation, planting systems, irrigation management, organic manuring, biofertilizers, chemical fertilizers, and pruning/harvesting schedules. **Crop Protection:** Biology, symptoms, and Integrated Pest & Disease Management (IPDM) of major mulberry pests (tukra, thrips, stem borer) and diseases (powdery mildew, leaf spot, root rot).
III	**Morphology & Anatomy:** External morphology and internal anatomical systems (digestive, respiratory, circulatory, excretory, reproductive, and silk glands) of *Bombyx mori*. **Life Cycle & Development:** Embryonic development, post-embryonic development, larval instar dynamics, moulting, and spinning physiology. **Racial Classification:** Voltinism (univoltine, bivoltine, multivoltine), moultinism, geographical distribution, indigenous vs. exotic commercial races, and hybrid vigor **Diapause & Grainage Management:** Mechanism and hormonal regulation of egg diapause; cold storage protocols, acid treatment, grainage operations, seed production, and egg transportation.
IV	**Infrastructure & Equipment:** Design and environmental control (temperature, humidity, ventilation) of rearing houses; disinfectants and rearing appliances.

	Rearing Operations: Disinfection, brushing, feeding strategies, spacing, and moulting care. **Rearing Techniques:** Chawki (young age) rearing vs. late-age rearing methods (shelf, floor, and shoot rearing). **Pathology of *Bombyx mori*:** Etiology, mode of infection, symptoms, and control measures of Pebrine (protozoan), Flacherie (bacterial), Grasserie (viral), and Muscardine (fungal). **Pest Management:** Biology, damage mechanisms, and control measures for Uzi fly (*Exorista bombycis*), dermestid beetles, mites, ants, and vertebrate pests.
V	**Cocoon Assessment:** Physical and commercial parameters (shell ratio, filament length, denier, renditta, neatness, and raw silk percentage). **Harvesting & Marketing:** Cocoon harvesting time, sorting, transportation, and market operations. **Reeling Technology:** Stifling (sun-drying, steam, hot air), deflossing, riddling, cooking, brushing, reeling (cottage basin, multi-end, automatic), and re-reeling. **Weaving & By-Products:** Degumming, bleaching, dyeing, and weaving principles. Value addition through sericulture by-products (mulberry fruit, pupal oil, chrysalis meal, pupal proteins, and silk waste utilization).
On completion of this course students will	
1	Examine the socio-economic status, historical development, and institutional role of sericulture in Indian rural development
2	Demonstrate proficiency in mulberry propagation methods (cuttings, grafting, tissue culture) and agronomic management practices (pruning, irrigation, manuring) and Identify major mulberry pests and diseases
3	Correlate the functional anatomy (particularly silk glands) of *Bombyx mori* with its physiological stages, larval moults, and voltinism categories.
4	Execute silkworm rearing operations—including disinfection, brushing, environmental regulation, and specialized techniques (Chawki and shoot rearing).
5	Assess commercial cocoon parameters (filament length, denier, renditta) and execute post-cocoon operations (stifling, cooking, reeling, and re-reeling).

Reading list

1. G. Ganga and J. Sulochana Chetty. 2019. An introduction to sericulture, 2nd edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. M. Johnson and M. Kesary. 2019. Sericulture, Saras publication, Tamilnadu.
3. Singh, Amardev & Ravinder Kumar. 2013. Sericulture handbook Vol 1, Biotech.
4. M. Madan Mohan Rao. An Introduction to Sericulture, 2nd edition, BS Publications.

Recommended websites

1. https://agritech.tnau.ac.in/sericulture/
2. https://csb.gov.in/

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	L	L	L	L	L	M	S	L	L
CO2	L	M	L	M	L	M	M	S	M	L
CO3	M	S	L	L	L	M	L	L	M	S
CO4	M	S	M	S	M	M	L	L	S	S

Course		Skill Enhancement Course 3			Code	BPZOSE2A
VERMICULTURE						
Credits	**3**	**Semester**		**IV**	**Hours/Week**	**3**
Marks	CIA	30	Ext	70	Total	100

Students should know basic concepts in Vermiculture.	
The main objectives of this course are:	
LO1	Describe the anatomical, physiological, and taxonomic characteristics of key earthworm species and articulate the foundational principles of vermitechnology
LO2	Analyze and optimize key environmental parameters (pH, temperature, moisture, carbon-to-nitrogen ratio) to design efficient indoor, outdoor, monoculture, and polyculture wormery systems
LO3	Evaluate and select appropriate vermicomposting methods (pit, heap, windrow, bin, and continuous flow-through systems) based on the physical and biological profile of target waste streams (agricultural, municipal, or agro-industrial).
LO4	Critically assess the biochemical impact of vermicastings on soil structure, nutrient dynamics, soil microbiology, and crop yield in organic farming, horticulture, and forestry applications
LO5	Design a commercially viable, sustainable vermibusiness framework—incorporating production logistics, quality control standards, market research, and regulatory compliance within the Indian socio-economic context
Pre-requisite:	
Students should be aware of economic and cultural importance of Vermiculture.	
Unit I	Earthworms: Taxonomic position, external features-shape, size, colour, segmentation, setae & clitellum. Body wall, coelom-locomotion, digestive, circulatory, respiratory, excretory & nervous system. Reproductive system: Male & Female, copulation, cocoon formation & fertilization, development of earth worm. Vermitechnology- Definition, history, growth and development in other countries & India, significance.
Unit II	Vermiculture: definition, common species for culture; Environmental parameters; culture methods: wormery - breeding techniques; indoor and outdoor cultures; monoculture and polyculture-merits and demerits.
Unit III	Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, static pile windrows, top fed windrows, wedges & bin method, harvesting the compost, storage.
Unit IV	Applications of vermiculture: Vermiculture Bio-technology, vermicomposting, use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration.
Unit V	Potentials and constraints for vermiculture in India. Marketing the products of vermiculture - quality control, market research, marketing techniques – creating the demand by awareness and demonstration, advertisements, packaging and transport, direct marketing. Economic importance of Earthworms: In sustainable agriculture, organic farming, earthworm activities, soil fertility & texture, soil aeration, water impercolation, decomposition & moisture, bait & food.
Expected Course Outcome:	
Upon completion of this course, Students would have	

LO1	To understand the various practices in vermiculture. To know the needs for Vermiculture and the status of India in global market.	**K2** **K3**
LO2	Able to apply the techniques and practices needed for vermiculture.	**K2** **K4**
LO3	To know the difficulties in Vermiculture and be able to propose plans against it	**K5** **K6**
LO4	The ability to apply this technique for organic waste management	**K3** **K4**
LO5	Knowledge on the marketing of this technique	**K3**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

1	Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Orient Longman, India
2	Bhatnagar, R.K. & R.K. Patla. 2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi. Pp 175. ISBN 9327268695
3	Mary Violet Christy, 2008. Vermitechnology, MJP Publishers, Chennai. Pp 132. ISBN
4	4. Aravind Kumar, 2005. Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi. Pp 200.

Recommended texts

1	https://agritech.tnau.ac.in/sericulture/
2	https://www.agrifarming.in/vermiculture-process-techniques-worm-farming
3	Edwards, C.A., and Bother, B., 1996. Biology of earthworms, Chapman Hall Publication Company

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	L	M	L	L	L	L	S	L	L	L
CO2	L	S	S	S	S	S	L	S	S	S
CO3	M	S	S	S	S	S	L	S	S	L
CO4	L	S	S	S	M	S	M	S	S	M
CO5	S	S	M	S	L	L	L	M	L	M

*S - Strong; M - Medium; L- Low

Course		Skill Enhancement Course 4		Code		BPZOSE2B	
BEE KEEPING							
Credits	**3**	**Semester**		**IV**		**Hours/Week**	**3**
Marks	CIA	30	Ext	70		Total	100

Course Objectives:	
The main objectives of this course are:	
LO1	Analyze the evolutionary biology, taxonomy, polyethism (division of labour), neuro-hormonal control of caste determination, and communication mechanisms across major honey bee species
LO2	Demonstrate proficiency in apiary establishment, seasonal management protocols, modern hive manipulations, and planned crop pollination services to optimize yield
LO3	Perform diagnostic analyses of viral, bacterial, fungal, protozoan, and parasitic diseases and formulate Integrated Pest and Disease Management strategies
LO4	Evaluate the biochemical profile, therapeutic properties, purity standards (FSSAI/BIS parameters), and value-addition techniques for diverse bee products
LO5	Formulate a sustainable business model and policy-aligned commercial enterprise-incorporating migratory beekeeping logistics, economics, quality assurance, and institutional linkages with in rural and agro-industrial sectors.
Pre-requisite:	
Students should be aware of importance of honey bees and their impacts on the ecosystem.	

Unit I	Introduction to Apiculture: History of Bees and Beekeeping, Systematics, Bee species, Bee morphology, Colony organization, Polymorphism, Caste system, Division of labour, Bee flora, Foraging and Honey flow periods.
Unit II	Bee keeping as an occupation: Extent of Beekeeping in India, Limitations on the development of beekeeping, Advantages of extensive Beekeeping. Beekeeping equipment: Bee box and tools and initiation into keeping a colony, the future of beekeeping.
Unit III	Purchase of a colony, the Apiary site, how to manage a colony, the manipulation of a colony. Bee products: Honey, Bee's wax, Pollens, Royal Jelly, Propolis and Bee venom. taking care of bee diseases and enemies. Establishment of a colony. Bee flora and planned pollination services
Unit IV	Diseases affecting honey bees and their control measures. Colony collapse disorder and its management.
Unit V	Routine management, Seasonal management, Migratory beekeeping, Harvesting and marketing of bee products. Important Institutions pertinent to Apiculture: National Bee Board, Bee research and Training Institute, Apiaries. Economics and extension of Bee keeping

Expected Course Outcome:		
Upon completion of this course, Students would have		
LO1	Knowledge on history, types and social behaviour of honey bees	**K1** **K2**
LO2	Clear understanding of morphology, life cycle, characteristics of honey bees and bee keeping.	**K2** **K3**

LO3	Acquired skills to perform bee keeping from managing colonies of bees in order to harvest honey and other Bee related by-products in different setups and as an Entrepreneurial venture.	**K3 K4**
LO4	Knowledge on the harvesting, preserving and processing of bee products and identification of the appropriate markets to sell the produce.	**K3**
LO5	Knowledge on the use of bee products	**K5**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Reading list

1. Singh, D., Singh, D. Pratap. 2006. A Handbook of Beekeeping. AGROBIOS (INDIA)
2. Sharma P.L. and Singh, S.H. Book of Bee keeping.
3. Cherian and Ramanathan, S. Bee keeping in south India.
4. Prospective in Indian Apiculture - R.C. Mishra.

Recommended texts

1. Caron, D.W. 2013 (revised from 1999). Honey Bee Biology and Beekeeping. Wicwas Press. Cheshire, CT, 368 pp.
2. Kaspar, R., C. Cook, and M. D. Breed. 2018. Animal Behaviour 142: 69-76.
3. Hendriksma, H. P., A. L. Toth, and S. Shafir. 2019. Individual and Colony Level Foraging decisions of Bumble Bees and Honey Bees in Relation to Balancing of Nutrient Needs. Frontiers in Ecology and Evolution 7: 177.
4. Steinhauer, N. et al. 2018. Drivers of Colony Loss. Current Opinion in Insect Science 26: 142-148.
5. Technology and value addition of Honey - Dr. D. M. Wakhle and K. D. Kamble.
6. ABC & XYZ of Bee culture - A. I. Root.

Mapping with Programme Outcomes*										
COs	**PO 1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	S	M	L	L	S	L	S	S	L	M
CO2	S	S	S	S	S	S	L	L	S	S
CO3	S	L	M	M	S	M	M	L	L	L
CO4	M	S	L	S	L	M	L	M	M	M
CO5	S	L	L	S	L	M	L	L	M	L

*S - Strong; M - Medium; L-Low

Extra Credit Courses

Course	**Extra Credit Course 1**	**Code**	**BPZOEC1**
INTELLECTUAL PROPERTY RIGHTS			
Credits	**2**	**Self-Study**	
Marks	External Only	Total	100

Course Objectives:

The main objectives of this course are:

1.	Students should gain basic knowledge in intellectual property rights

Pre-requisite:

Students should be aware of importance of analysis of quantitative and qualitative information from biological studies.

Expected Course Outcome:

On the successful completion of the course, student will be able to

LO1	basic knowledge on the various branches of Intellectual Property Law	**K1**
LO2	holistic understanding of the legalities of Intellectual Property Rights	**K2** **K3**
LO3	discuss contemporary issues in Intellectual Property Laws	**K1** **K2**
LO4	understanding intricacies involved in drafting filings for Intellectual Property registration	**K3**
LO5	analyzing steps of development of Intellectual Property	**K4**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Unit I	Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad - Genesis and Development - the way from WTO to WIPO - TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations - Important examples of IPR.
Unit II	Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad
Unit III	International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.
Unit IV	Digital Innovations and Developments as Knowledge Assets - IP Laws, Cyber Law and Digital Content Protection - Unfair Competition - Meaning and Relationship between Unfair Competition and IP Laws - Case Studies.
Unit V	Infringement of IPRs, Enforcement Measures, Emerging issues - Case Studies.

Reading list

1. Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.
2. Prabuddha Ganguli," Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

Recommended texts

1. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India Pvt Ltd, 2012
2. S.V Satakar Intellectual Property Rights and Copy Rights, Ess Publication, New Delhi, 2002.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	M	S	S	M	M	M
CO2	S	S	M	S	M	S	S	S	M	L
CO3	S	M	M	S	M	L	L	S	L	S
CO4	M	M	S	L	M	S	S	S	S	S
CO5	M	S	S	L	S	M	M	L	L	S

*S - Strong; M - Medium; L – Low

Course	Extra Credit Course 2	Code	BPZOEC2
DAIRY FARMING			
Credits	**2**	**Hours/Week**	**Self-study**
Marks	External Only	Total	100

The main objectives of this course are:

1. Students should know basic concepts of Dairy Farming

Pre-requisite:

Students should be aware of economic and cultural importance of Dairy farming.

Expected Course Outcome:

Upon completion of this course, Students would

1	know the needs for dairy farming and the status of India in global market.	**K1**
2	understand the various breeds and practices in Dairy farming.	**K2**
3	able to apply the techniques and practices needed for Dairy farming.	**K3**
4	know the difficulties in dairy farming and be able to propose plans against it. Quality and nutritional aspects of milk	**K4** **K5**
5	diagnose the diseases of dairy cattle	**K3** **K4**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Unit I	Introduction to Dairy Farming: Advantages of dairying-Classification of breeds of cattle-Indigenous and exotic breeds-Selection of dairy cattle. Breeding-artificial insemination-Dairy cattle management-General Anatomy.
Unit II	Construction of Model Dairy House: Types of Housing, Different Managemental Parameters-Winter Management-Summer Management
Unit III	Feedstuffs available for livestock: Roughages-Concentrates-Energy rich concentrates-Protein rich concentrates-Mineral and Vitamin supplements. Feed additives. Feeding management. Calves Feeding, feeding of adults, feeding of pregnant dairy animals, feeding pregnant heifer.
Unit IV	Milk-Composition of milk-milk spoilage-pasteurization - Role of milk and milk products in human nutrition – Dairying as a source of additional income and employment.
Unit V	Contagious disease - Common Bacterial - Protozoal - Helminth and Viral Diseases - Parasitic Infestation - Vaccination - Biosecurity.

Reading list

1. Roger W. Blowey. 2016. The Veterinary Books for Dairy Farmers. Old Pond Publishing Ltd.
2. Board Eiri. Hand Book of Dairy Farming. Engineers India Research Institute. Pp 176
3. Handbook of animal husbandry TATA, S.N ed., ICAR 1990
4. Hafez, E.S.E. 1962. Reproduction in Farm Animals, Lea & amp; Fabiger Publisher.
5. James. N. Marner, 1975. Principles of dairy processing, Wiley eastern limited, New Delhi

Recommended texts

https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Dairy%20unit.html
https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Tata,+S.N.,+ed%22

Mapping with Programme Outcomes*										
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**
CO1	M	S	L	L	S	S	M	S	L	M

CO2	M	S	S	S	M	S	M	L	S	S
CO3	M	S	S	S	S	S	S	S	S	M
CO4	M	S	S	S	M	M	L	L	M	M
CO5	S	S	S	M	S	M	S	L	S	S

*S - Strong; M - Medium; L – Low

Course	Extra Credit Course 3	Code	BPZOEC3
Animal Behaviour			
Credits	**2**	**Hours/Week**	**Self-Study**
Marks	External Only	Total	100

The main objectives of this course are:

1.	Students should understand basic concepts of Animal behaviour.

Pre-requisite:

Students should be aware of ecology and the animals in their respective environments.

Expected Course Outcome:

Upon completion of this course, Students would have

1	Recall and record genetic basis and evolutionary history of behaviour.	**K1 & K2**
2	Analyse and identify innate, learned and cognitive behaviour and differentiate between various mating systems.	**K3 & K4**
3	Classify movement and migration behaviours and explain environmental influence upon behaviour.	**K1, K4 & K5**
4	Knowledge on different types of behaviour in different animals	**K2**
5	Know the concept of biological clock and its application	**K3**

K1- Remember; **K2**- Understand; **K3**- Apply; **K4**-Analyze; **K5**-Evaluate; **K6**- Create

Unit I	Genetic material, Genes and chromosomes, Genetic variation, Single and Polygenic inheritance of behaviour, Heritability of behaviour, Natural selection and behaviour, Frequency distribution of phenotypes, Darwinian fitness, Evolution of adaptive strategies.
Unit II	Sexual selection, Altruism, Sexual strategy and social organisation, Animal perception, Neural control of behaviour, Sensory processes and perception, Visual adaptations to unfavourable environments.
Unit III	Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning.
Unit IV	Instinct and learning, Displacement activities, Ritualization and Communication, Decision making behaviour in Animals, Complex behaviour of honey bees, Evolutionary optimality, Mechanism of Decision making. The mentality of Animals: Languages and mental representation, non-verbal communication in human, mental images, Intelligence, tool use and culture, Animal awareness and Emotion.
Unit V	Organization of circadian system in multicellular animals; Concept of central and peripheral clock system; Circadian pacemaker system in invertebrates with particular reference to Drosophila; Photoreception and photo- transduction; Molecular bases of seasonality; The relevance of biological clocks for human welfare - Clock function (dysfunction); Human health and diseases – Chrono pharmacology, chrono medicine, chronotherapy.

Reading list

1. David McFarland, 1985.Animal Behaviour, Longman Scientific & Technical, UK.576pp.

2. Harjindra Singh, 1990. A Textbook of Animal Behaviour, Anomol Publication, 293pp.
3. Hoshang S. Gundevia and Hare Goving Singh, 1996. Animal Behaviour, S. Chand &Co, 280pp.
4. Shukla, J. P 2010, Fundamentals of Animal Behaviour, Atlantic, 587pp.
5. Vinod Kumar, 2002. Biological Rhythms. Narosa Publishing House, Delhi.

Recommended texts

1. Michael D. Breed and Janice Moore, 2012. Animal Behaviour, Academic Press, USA, 359pp.
2. Aubrey Manning and Martin Stamp Dawkins, 2012. An Introduction to Animal Behaviour, 6th Edition, Cambridge University Press, UK. 458pp.
3. Davis E.Davis, 1970. Integral Animal Behaviour, Mac Millan Company, London, 118pp.
4. Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (ed). 2004. Chronobiology Biological time Keeping, Sinauer Associates Inc, Publishers, Sunderland, MA.

Mapping with Programme Outcomes*

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	S	S	M	M	L	L	M	M	L	L
CO2	S	M	L	L	S	L	M	M	L	M
CO3	M	L	M	L	S	S	M	S	M	S
CO4	S	S	S	S	M	S	L	L	L	M
CO5	S	L	L	L	M	L	L	S	M	S

*S - Strong; M - Medium; L- Low