ST. XAVIER'S COLLEGE (AUTONOMOUS)
Palayamkottai 627002

Affiliated to *Manonmaniam Sundaranar University, Tirunelveli*
(Recognized as "College with Potential for Excellence" by UGC)
(Accredited with "A^{++}" Grade with a CGPA of 3.66/4 in IV cycle)

SYLLABUS

M. Sc. ZOOLOGY

(w.e.f. June 2023)

Programme Name: M.Sc. ZOOLOGY
Programme Code: PZO

Programme Outcomes (POs) for PG Programmes

Students of all Postgraduate Degree Programmes at the time of graduation will be able to attain the following:

PO1. Critical thinking: Acquire the knowledge in the respective field and take informed actions.

PO2. Communication: Speak, read, write and listen clearly in person and through electronic media in English and in one Indian language, and make meaning of the world by connecting people, ideas, books, media and technology

PO3. Individual and teamwork: Function effectively as an individual, and a member or leader in diverse teams, and in multidisciplinary settings.

PO4. Problem analysis: Identify, formulate, review research literature, and analyze complex problems reaching substantiated conclusions using the principles of all branches of sciences, commerce, economics, management studies, language and literature.

PO5. Design / development of solutions: Design solutions for problems and design system components or processes that meet the specified needs with appropriate consideration for the public, health and safety, and the cultural, societal and environmental considerations.

PO6. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO7. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern IT tools including prediction and modeling to complex activities with an understanding of the limitations.

PO8. Self-directed and life-long learning: Recognized the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of socio-technological changes.

Programme Specific Objectives

1. M.Sc. in Zoology is a two-year post-graduate academic degree programme which focuses on the studies relating to animals. The teaching programme in the department is interdisciplinary and the course covers the emerging areas in life sciences.
2. These include courses like Structure and Function of Invertebrates, Comparative Anatomy of Chordates, Biochemistry, Ecology, Research Methodology, Biostatistics, Immunology and Microbiology, Genetics, Developmental Biology, Bioinstrumentation, Bioinformatics, Biotechnology, Evolution, Cell and Molecular Biology, Comparative Animal Physiology, Animal Husbandry, Apiculture, Entomology, Aquaculture, Poultry Farming, and Sericulture in M.Sc. teaching programme.
3. Hands-on practical training to the students is one of the outstanding features of the M.Sc. Zoology programme.
4. The teaching and research laboratories in the department are very well equipped with all the required instruments / equipments and students are always encouraged to use them.
5. The department houses a library catering to the needs of the students. Special efforts are made to add latest text books and scientific journals to the collection. M.Sc. students of the department have access to the internet facilities for academic purposes.
6. In order to expose the students to research environment, every student is also required to complete a small research project during the second year of the programme.
7. Every year study tour is arranged to various places in India, as part of the M.Sc. curriculum.
8. The research activities of the department are also recognised nationally and internationally and cover areas such as aquaculture and entomology with sharp focus on molecular biology, genetics, cell and developmental biology, animal physiology etc. The faculty members of this department have received several research grants from various national and international agencies.

Programme Specific Outcomes

On completion of the M.Sc. programme in Zoology the students will be able to:

1. Describe the biochemistry of bio-molecules, its metabolism and functions.
2. Understand ultra-structure and functions of various cellular organelles including cancerous cells and cell signaling.
3. Demonstrate parametric and non-parametric statistics and their biological applications.
4. Outline taxonomy, diversity of animals and their comparative functional anatomy.
5. Summarize ecosystem, bio-resources and their management, role of GMOs in biodegradation of xenobiotic compounds.
6. Summarize classical and modern genetics, genetic disorders, genetic counseling, tools and applications of genetic engineering and biotechnology.
7. Describe structure and functions of various organ systems and the physiology of animals and human beings.
8. Comprehend the concepts of ecosystem and to understand the impact of environment and their management strategies.
9. Describe fundamentals of the developmental process of various organisms.
10. Trace the origin of life and evolution, evolutionary processes, major trends of evolution and future of man.

Employment and higher studies opportunities for M.Sc. Zoology students

1. The higher studies options after M.Sc. Zoology are: Master of Philosophy in Zoology, Master of Philosophy in Life Science, Ph.D. in Zoology/Biotechnology / Life Sciences.
2. A Master degree holder is eligible to write competitive exams like NET, SET, placement as Project Assistant, employability in Fishery Board of India and Department of Sericulture and Department of Forests, Government of Tamil Nadu, Central Silk Board, etc.
3. P.G students are eligible for B.Ed., TNPSC, IAS, IPS, IFS (Group 1 exams), Biological Laboratory Technician, Conservationist, Environmental Consultant, Herpetologist, Veterinary Technologist, Wildlife Educator, Wildlife Rehabilitator, Zoologist, etc.

COURSE STRUCTURE FOR M. Sc. ZOOLOGY

Sem	Part	Status	Subject Code	Title	Hrs	Credits
I	A	Core - 1	23PZOC11	Structure and Function of Invertebrates	6	5
		Core -2	23PZOC12	Comparative Anatomy of Chordates	6	5
		Core-3	23PZOC13	Structure and Function of Invertebrates & Comparative Anatomy of Chordates-Practical	4	2
		Core-4	23PZOC14	Biochemistry & Biostatistics-Practical	4	2
	B	EC-1	23PZOE11	Biochemistry	5	3
		EC-2	23PZOE12	Biostatistics	5	3
				Sub Total	**30**	**20**
II	A	Core – 5	23PZOC21	Cellular and Molecular Biology	5	5
		Core – 6	23PZOC22	Developmental Biology	5	5
		Core-7	23PZOC23	Cellular and Molecular Biology & Developmental Biology- Practical	4	2
		Core-8	23PZOC24	Economic Entomology-Practical	4	2
	B	EC-3	23PZOE21	Economic Entomology	4	3
		EC-4	23PZOE22	Research Methodology	4	3
		SEC-1	23PZOS21	Poultry farming	4	2
				Sub Total	**30**	**22**
III	A	Core-9	23PZOC31	Evolution	5	5
		Core-10	23PZOC32	Animal Physiology	5	5
		Core-11	23PZOC33	Evolution and Genetics - Practical	4	2
		Core -12	23PZOC34	Animal Physiology - Practical	4	2
	B	EC-5	23PZOE31	Genetics	4	4
		SEC-2	23PZOS31	Animal Husbandry	4	3
		SEC-3	23PZOS32	Stem cell Biology	4	3
		Internship	23PZOI31	Carried out in summer vacation at the end of Semester II		2
				Sub Total	**30**	**26**
IV	A	Core-13	23PZOC41	Immunology and Microbiology	4	4
		Core-14	23PZOC42	Aquaculture	4	4
		Core-15	23PZOC43	Immunology and Microbiology - Practical	4	2
		Project	23PZOC44	Project with viva voce	10	7
	B	EC-6	23PZOE41	Aquaculture and Ecology- Practical	4	2
		SEC-4	23PZOS41	Ecology	4	3
		Extension Activity		STAND Carried out in the 1 year		1
				Sub Total	**30**	**23**
				Total	**120**	**91**
				Additional Compulsory Courses		
I PG		Value Added	23PZOVA11 / 23PZOVA12	Intellectual Property rights / Dairy Farming		**3**
		ECC	23PZOEC1 / 23PZOEC2 / 23PZOEC3 / 23PZOEC4	Biodiversity / Medical Entomology / Animal Behaviour / Biopesticides		**3**
				GRAND TOTAL	**120**	**97**

STRUCTURE AND FUNCTION OF INVERTEBRATES

(Subject code: 23PZOC11)

Semester: I Core: 1 Credits: 5 Hours: 6

Course objective: To outline the basic concepts of taxonomy, classification and body organization of selected invertebrates.

Course outcomes: At the end of the course the students will be able to

1. Highlighting an overview of the classification of invertebrates (**K1)**
2. Comparing the structure, function and life cycle of selected invertebrates **(K2)**
3. Examine the adaptive significance of invertebrates and analyse the ecological role of representative organisms in each phyla(**K3)**
4. Explaining structure and function of the respiratory and nervous system (**K4)**
5. Compare and review phylogenetic relationships between the phyla covered (**K5)**
6. Facilitate to identify and name invertebrates with the use of literature and other resources (**K6)**

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

Unit I: Principles of animal taxonomy **18 Hours**

Species concept; International Code of Zoological nomenclature - Taxonomic procedures. New trends in taxonomy - Animal collection, handling and preservation - Organization of coelom - Acoelomates – Pseudocoelomates - Coelomates: Protostomia and Deuterostomia.

Unit II: Locomotion **18 Hours**

Pseudopodia-Flagella and ciliary movement in protozoa-Hydrostatic movement in Coelenterata, Annelida and Echinodermata - Nutrition and Digestion - Patterns of feeding and digestion in lower metazoan -Filter feeding in Polychaeta, Mollusca and Echinodermata.

Unit III: Respiration **18 Hours**

Organs of respiration: gills, lungs and trachea-Respiratory pigments- Mechanism of respiration-Excretion- Organs of excretion: coelom, coelomoducts, nephridia and Malphigian tubules - mechanisms of excretion-Excretion and osmoregulation

Unit IV: Nervous system **18 Hours**

Primitive nervous system: Coelenterata and Echinodermata - Advanced nervous system: Annelida, Arthropoda (crustaceans and insects) and Mollusca (Cephalopoda) - Trends in neural evolution.

Unit V: Invertebrata larvae **18 Hours**

Larval forms of free living invertebrates-Larval forms of parasites - Strategies and evolutionary significance of larval forms-Minor Phyla(Structural features and affinity)-Concept and significance-Organization and general characters (Mesozoa, Rhynchocoela, Rotifera, Phoronida)

Textbooks:

1. Barrington, E. J. W. (2012). Invertebrate Structure and Function. 2nd edition. Affiliated East West Press Pvt. Ltd., New Delhi. 765 pages.
2. Gonzalo Giribet, Richard C. Brusca, Wendy Moore. (2022). Invertebrates. 4th edition. Oxford University Press, USA. 1104 pages.
3. Veer Bala Rastogi. (2021). Parker and Haswell Textbook of Zoology. Volume I – Invertebrates. Medtech Science Press. 970 pages.

Reference books:

1. L. H. Hyman. (1992). The Invertebrates. Volumes 1 – 6. McGraw Hill, New York.
2. Henry Pratt Sherring. (2021). A Course in Invertebrate Zoology. MJP Publishers. 224 pages.
3. Robert D. Barnes. (2006). Invertebrate Zoology: A Functional Evolutionary Approach. 7th edition. Cengage Publishers. 928 pages.
4. Jan A. Pechenik. (2019). Biology of the Invertebrates. 7th edition. McGraw Hill Education.
5. Adam Sedgwick. (2022). A Student's Textbook of Zoology. Legare Street Press. 630 pages.
6. Gonzalo Giribet, Gregory D. Edgecombe. (2020).The Invertebrate Tree of Life. Illustrated edition. Princeton University Press. 608 pages.
7. Gosta Jagersten. (1972). Evolution of the Metazoan Life Cycle. Academic Press. 282 pages.
8. W. D. Russell-Hunter. (1969). Biology of Higher Invertebrates, Collier Macmillan Ltd., London. 224 pages.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M
CO6	S	M	S	M	S	S	M	M

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

COMPARATIVE ANATOMY OF CHORDATES

(Subject code: 23PZOC12)

Semester: I Core: 2 Credits: 5 Hours: 6

Course objective: This course introduces the taxonomy, diversity, and functional anatomy of chordates.

Course outcomes: At the end of the course the students will be able to

1. Outlining the salient features of chordates
2. Understand the basic principles and definition of taxonomy (**K1** & **K2**).
3. Examining the structural organization adaptive features of animals (**K1** & **K2**).
4. Demonstrate the concepts of the methodology of animal classifications (**K2** & **K3**).
5. Summarize the comparative functional anatomy of vertebrates (**K4** & **K5**).
6. Integrate the structure and function of animals (**K5** & **K6**).

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

Unit I: Origin of chordata (18 Hours)

Concept of protochordata - The nature of vertebrate morphology - Definition, scope and relation to other disciplines-Importance of the study of vertebrate morphology.

Unit II: Development, Structure and functions of integuments (18 Hours)

Vertebrate integument and its derivatives -Development, general structure and functions of skin and its derivatives-Glands, scales, horns, claws, nail, hoofs, feathers and hairs.

Unit III: General plan of circulation and respiration (18 Hours)

Structural and Functional modifications of heart, aortic arches and portal systems -Respiratory system -Characters of respiratory tissue - Internal and external respiration - Comparative account of respiratory organs.

Unit IV: Skeletal and Urino-genital system (18 Hours)

Form, function, body size and skeletal elements of the body - Comparative account of jaw suspensorium, vertebral column-Limbs and girdles-Evolution of urino-genital system in vertebrate series.

Unit V: Sense organs and nervous system (18 Hours)

Simple receptors, Organs of olfaction, taste and hearing; 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 system.

Textbooks:

1. R. C. Gupta, Girish Chopra. (2020). Comparative Anatomy of Chordates. 8th edition. R. Chand & Co. 510 pages.
2. R. K. Saxena, Sumitra Saxena. (2020). Comparative Anatomy of Vertebrates. 2nd edition. Viva Books Private Limited. 676 pages.

3. Tripurari Mishra, Diwakar Mishra, Susmita Srivastav. (2021). Comparative Anatomy of Vertebrates with Practical. Mahaveer Publications. 350 pages.

Reference books:

1. Kenneth Kardong. (2008). Vertebrates. Comparative Anatomy, Function, Evolution. 5th edition. McGraw Hill Education. 800 pages.
2. G. C. Kent. (2018). Comparative Anatomy of the Vertebrates. 9th edition. McGraw Hill Education.
3. Karel F. Liem, William Bernis, Warren Walker, Lance Grande. (2001). Functional Anatomy of the Vertebrates: An Evolutionary Perspective. 3rd edition. S. Chand Company. 784 pages.
4. Theodore H. Eaton. (2015). Comparative Anatomy of the Vertebrates. Scientific Publishers.
5. J. S. Kingsley. (2016). Outlines of Comparative Anatomy of Vertebrates. Wentworth Press. 464 pages.
6. M. Hildebrand, G. Goslow. (2001). Analysis of Vertebrate Structure. 5th edition. John Wiley & Sons. 656 pages.
7. Charles K. Weichert. (1970). Anatomy of the Chordates. 4th edition. McGraw-Hill College. 780 pages.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	M	L	S	M	S	M	S
CO2	S	L	L	S	M	S	M	M
CO3	S	M	L	S	M	S	M	L
CO4	S	L	L	S	L	S	M	L
CO5	S	M	L	S	S	S	M	S
CO6	S	L	L	S	M	S	M	M

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

STRUCTURE AND FUNCTION OF INVERTEBRATES& COMPARATIVE ANATOMY OF CHORDATES - PRACTICAL

(Subject code: 23PZOC13)

Semester: I **Core: 3** **Credits: 2** **Hours: 4**

Dissection

Cockroach	:	Nervous system
Cockroach	:	Reproductive System
Cockroach	:	Digestive System
Prawn	:	Nervous System
Crab	:	Nervous system
Fish	:	Reproductive System
Fish	:	Digestive System

Mounting

Earthworm	:	Body setae
Cockroach	:	Mouth parts
Prawn	:	Appendages
Shark	:	Scales
Fish	:	Scales
Fish	:	Weberianossicles of fish
Birds	:	Feathers
Mammals	:	Hair

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

1. *Amoeba*
2. *Paramecium*
3. *Hydra* with bud
4. Liver fluke
5. Cercarialarva
6. Tape worm
7. *Ascaris*
8. Scorpion
9. *Penaeusindicus*
10. *Emerita* (*Hippa*)
11. *Pernaviridis*
12. Mysis of prawn
13. *Amphioxus* sp. (Lancelet)
14. *Ascidia* sp. (sea squirt)
15. *Scoliodonlaticaudatus*(Indian dog shark)
16. *Trygon*sp. (Sting ray)

17. *Torpedo* sp. (Electric ray)
18. *Arius maculatus*(Cat fish)
19. *Belonecancila*(Flute fish)
20. *Exocoetuspoecilopterus*(Flying fish)
21. *Mugilcephalus*(Mullet)
22. *Tilapia mossambicus*(Tilapia)
23. *Rachycentroncanadum*(Cobia)
24. *Tetrodonpunctatus*(Puffer fish)
25. *Dendrophis*sp. (Tree snake)

Study of the Frog or Rabbit skeleton system (Representative samples)

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

BIOCHEMISTRY & BIOSTATISTICS- PRACTICAL

(Subject code: 23PZOC14)

Semester: I Core: 4 Credits: 2 Hours: 4

BIOCHEMISTRY

1. Concept of pH, measuring pH of different solutions
2. Preparation of buffers: Acetate, Phosphate and Tris buffers
3. Estimation of Carbohydrate in fish muscles/liver
4. Estimation of salivary amylase activity
5. Estimation of protein by Lowry's method/ Bradford method
6. Estimation of protease activity
7. Estimation of nucleic acids (DNA) using blood sample
8. Estimation of iodine value in edible oils
9. Determination of acid value of fats and oils
10. Determination of saponification value of fats and oils
11. Estimation of cholesterol in blood serum (colorimetric)
12. Estimation of ascorbic acid by Titrimetric method
13. Separation of lipids by TLC
14. Separation of amino acids by ascending paper chromatography

Spotters: Biochemistry: Structure of glucose, Starch, Structure of protein, Myoglobin, Haemoglobin, α -lecithin, Cephalin, Stearic acid, Oleic acid, Cyclic AMP, Urea cycle, Kreb's cycle, Structure of DNA, Types of DNA, Structure & types of RNA, Enzyme action- lock and key model, Induced fit model; Fat soluble vitamins and water soluble vitamins and hormonal action (steroid and peptide). Instruments**:** pH meter, colorimeter, Paper chromatography, gel electrophoresis, spectrophotometer and centrifuge.

BIOSTATISTICS

15. Calculation of mean, standard deviation and standard error using marine shell
16. Correlation- Students height and weight.
17. Probability – tossing with two and three coins.
18. Regression analysis – neem leaflets
19. MS EXCEL Functions– *t* - test, F-test and Z-test.
20. SPSS – One way /Two way ANOVA calculation

Spotters: Biostatistics- Histogram, bar diagram, pictogram, pie chart, frequency polygon, venn diagram, types of correlation.

BIOCHEMISTRY

(Subject code: 23PZOE11)

Semester: I Elective: 1 Credits: 3 Hours: 5

Course objective: To understand the structure and properties of essential nutrients including carbohydrates, protein, lipid, nucleic acid and to find out the metabolic pathways of various nutrient types and to know about the biochemical aspects of vitamins and hormones.

Course outcomes: At the end of the course the students will be able to

1. Understand and remember the basics of the classification of carbohydrates, proteins and lipids; their structure, properties, and function (**K1** &**K2**)**.**
2. Analyze the basic structure of nucleic acids and the classification, structure and properties of enzymes (**K2** &**K3**)**.**
3. Illustrate the metabolism of carbohydrates, proteins and lipids (**K4** &**K5**)**.**
4. Classify vitamins, their sources, properties and biological role (**K3, K4** &**K5**)**.**
5. Summarize hormones and their biochemistry (**K2, K3 & K4**)**.**
6. Integrate the actions of proteins, nucleic acids, carbohydrates and lipids **(K6)**

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

Unit I : Interactions in Biomolecules (15 Hours)

Structure of atoms, molecules and chemical bonds., Stabilizing interactions (Vander Waals, electrostatic and hydrophobic interaction). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics and colligative properties)

Unit II : Carbohydrates, Proteins and Lipids (15 Hours)

Carbohydrates: Monosaccharides - general structure and properties; oligosaccharides; Polysaccharides; Proteins: Amino acids – Peptides, Protein configuration - classification - properties; general structure - Primary, secondary, tertiary and quaternary structure, Ramachandran plot; Lipids classification, properties of fats and fatty acids.

Unit III : Nucleic Acids and Enzymes (15 Hours)

Nucleic Acids – Chemistry, nucleosides, nucleotides variants of DNA, single stranded DNA; RNA - types and chemistry; Enzymes – nomenclature, classification, three dimensional structure mechanism of action, enzyme kinetics and enzyme regulation and Isoenzymes.

Unit IV : Metabolism (15 Hours)

Glycolysis, alcoholic fermentation, pyruvate oxidation, citric acid cycle, HMP pathway, glyoxylate cycle, electron transport, oxidative phosphorylation; oxidation of even chain fatty acids (oxidation), unsaturated fatty acids and odd chain fatty acids; Amino acid metabolism, Metabolism of nucleotides.

Unit V : Vitamins and Hormones **(15 Hours)**

Fat soluble vitamins –characteristic features, structure, deficiency; Water soluble vitamins – characteristic features, structure, deficiency; coenzyme Q, metabolism of vitamin A and C

General function and outline classification - steroid hormones, peptide hormones, amino acid derivatives, para-hormones, vasoactive peptides, pheromones, mechanism of hormone action.

Textbooks:

1. Peter J. Kennelly, Kathleen M. Botham, Owen McGuinness, Victor W. Rodwell, P. Anthony Weil. (2022). Harper's Illustrated Biochemistry, 32nd edition, McGraw-Hill Education. 816 pages.
2. U. Satyanarayana, U. Chakrapani. (2020). Biochemistry, 5th edition, Elsevier. 777 pages.
3. J. L. Jain, Sunjay Jain, Nitin Jain. (2016). Fundamentals of biochemistry, S. Chand & Co. Ltd., New Delhi. 1264 pages.

Reference books:

1. K. Ramadevi. (2016). Ambika Shanmugam's Fundamentals of Biochemistry for Medical Students. 8th edition. Wolters Kluwer (India) Pvt. Ltd. 590 pages.
2. Prasad R. Manjeshwar. (2023). Biochemistry Simplified - Textbook of Biochemistry for Medical Students. 6th edition. Prasad Book House. 640 pages.
3. D. M. Vasudevan. (2023). Textbook of Biochemistry for Medical Students. 10th edition. Jaypee Brothers Medical Publishers. 922 pages.
4. Denise R. Ferrier. (2020). Lippincott's Illustrated Reviews - Biochemistry South Asian Edition. Wolters Kluwer (India) Pvt. Ltd. 950 pages.
5. David L. Nelson, Michael M. Cox. (2017). Lehninger - Principles of Biochemistry. 7th edition. W. H. Freeman. 1172 pages.
6. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto. (2015). Biochemistry. 8th edition. W. H. Freeman. 1120 pages.
7. A. Hofmann, S. Clokie. (2018). Wilson and Walker's - Principles and Techniques of Biochemistry and Molecular Biology. 8th edition. Cambridge University Press. 929 pages.
8. Harold H. Trimm, William Hunter Jr. (2021). Recent Advances in Biochemistry. Apple Academic Press. 307 pages.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

BIOSTATISTICS

(Subject code: 23PZOE12)

Semester: I **Elective: 2** **Credits: 3** **Hours: 5**

Course objective: To know basic concepts in Biostatistics

Course outcomes: Upon completion of this course, students will be able to

1. Describe basic concepts of biostatistics (**K1**).
2. Understand the design and application of biostatistics relevant to experimental and population studies (**K2** &**K3**).
3. Acquire skills to perform various statistical analyses using modern statistical techniques and software (**K3** &**K4**).
4. Apply basic statistical tool sin data analysis **(K3)**
5. Know 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**).
6. Propose and implement appropriate statistical design/ methods of analysis (**K6**).

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

Unit I: Introduction to Statistics **(15 Hours)**

Definition, scope and application of statistics; Primary and secondary data: Source and implications; Classification and tabulation of biological data: Types and applications. Variables: Definition and types. Frequency distribution: Construction of frequency distribution table for grouped data; Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.

Unit II: Measures of Central Tendency **(15 Hours)**

Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error (one sample and two samples) and coefficient of variation; box plot and Venn diagram.

Unit III: Probability, Correlation and Regression **(15 Hours)**

Probability - theories and rules; addition and multiplication theorem; probability distribution: Properties and application of Binomial, Poisson and Normal distributions; Correlation - Karl Pearson's and Spearman's, significance test for correlation coefficients. Regression - simple and multiple; regression coefficient, graphical representation and prediction.

Unit IV: Hypothesis testing **(15 Hours)**

Hypothesis testing: Student 't' test (paired sample and mean difference); F-test; degrees of freedom; Variance: One-way and two-way classification; Parametric tests -ANOVA - one way, two way; Non-parametric tests- Chi-square test, Wilcoxon signed rank test, Mann-Whitney test, Kolmogorov - Snirnow test.

Unit V: Statistical analyses with M.S. Excel and SPSS (15 Hours)

Standard tool bars and menus, statistical functions and applications (*t*, and F significance tests, correlations, ANOVA); chart and table creation, saving and printing. SPSS: Data file structure - variable, editing and manipulating data, analysis, saving and printing

Textbooks:

1. Jerrold H. Zar. (2014). Biostatistical Analysis. 5th edition. Pearson Education India. 760 pages.
2. Norman T. J. Bailey. (1995). Statistical Methods in Biology. 3rd edition. Cambridge University Press. 272 pages.
3. A. Rajathi, P. Chandran. (2011). SPSS for you, MJP Publishers. 288 pages.

Reference books:

1. B. Antonisamy, Prasanna S. Premkumar, Solomon Christopher. (2017). Principles and Practice of Biostatistics. Elsevier. 390 pages.
2. Wayne W. Daniel, Chad L. Cross. (2014). Biostatistics: Basic Concepts and Methodology for the Health Sciences. 10th edition. Wiley. 954 pages.
3. Marcello Pagano, Kimberlee Gauvreau. (2018). Principles of Biostatistics. 2nd edition. Chapman & Hall. 584 pages.
4. Indranil Shah, Boddy Paul. (2020). Essentials of Biostatistics & Research Methodology. 3rd edition. Academic Publishers.
5. Thomas Glover, Kevin Michell. (2015). An Introduction to Biostatistics. Waveland Publishers. 539 pages.
6. Bratati Bannerjee. (2018). Mahajan's Methods in Biostatistics for Medical Students and Research Workers. 9th edition. Jaypee Brothers Medical Publishers. 488 pages.
7. Robert R. Sokal, F. James Rohfl. (1994). Biometry: Principles and Practice of Statistics in Biological Research. W. H. Freeman. 896 pages.
8. George W. Snecdecor, William G. Cochran. (1989). Statistical Methods. 8th edition. Wiley-Blackwell. 524 pages.

Robert R. Sokal, F. James Rohfl. (1987). Introduction to Biostatistics. 2nd edition. W. H. Freeman. 363 pages.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	M	L	M	S	S	M	S
CO2	S	S	S	S	S	S	S	S
CO3	M	S	S	S	S	S	S	S
CO4	M	M	S	L	M	M	M	S
CO5	M	M	S	L	M	S	M	L

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

CELLULAR AND MOLECULAR BIOLOGY

(Subject Code: 23PZOC21)

Semester: II Core: 5 Credits: 5 Hours: 5

Objective: To understand the structure and functions of cell organelles and to clarify the characteristics of nucleic acids, cancer and cell signaling conditions.

Expected outcomes: At the end of the course the students will be able to

1. Study of various aspects of cell organelles **(K1)**
2. Describe cell structure and how it relates to cell functions **(K1 & K2).**
3. Comprehend the structure and function of nucleus and events of cell divisions **(K3 & K4).**
4. Demonstrate mutations and DNA repair **(K4& K5).**
5. Develop safe and effective methods to prevent, detect, diagnose cancer cells**(K6)**
6. Integrate the structure and function of cell organelles **(K6).**

Unit I: Cell Organelles (14 Hours)

Ultra structure, organisation and functions - Plasma membrane, Mitochondria, Endoplasmic reticulum, Golgibodies, Peroxisomes, Ribosome, Lysosome, Vacuoles, Plastids, Microtubules

Unit II: Nucleus, Chromosomes, Cell cycle and Division (14 Hours)

Structural organization of Nucleus; Structure of chromatin and Chromosomes, karyotypes, euchromatin, heterochromatin, transposons, polytene and lamp brush chromosomes; Cell division and cell cycle - Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

Unit III: Nucleic Acids, Mutations and DNA repair (14 Hours)

Nucleic acids- DNA and RNA as genetic materials; DNA replication – units of replication, enzymes involved, replication origin, fork, and fidelity; Genetic code – characteristics; DNA mutation- spontaneous, and frame-shift; DNA repair mechanism- photo reactivation, mismatch and SOS repair, excision, recombinational repair; RNA synthesis and processing.

Unit IV: Protein synthesis and cancer studies (14 Hours)

Transcription, protein synthesis-initiation, elongation and termination process, post-translation modification of proteins; Regulation of gene expression in prokaryotes and eukaryotes; Role of chromatin in gene expression and gene silencing; Tumour causes and properties, oncogenes, suppressor genes, interaction of cancer cells with normal cells and apoptosis.

Unit V: Cell signalling (14 Hours)

General principles, signalling molecules (hormones) and their receptors; cell surface receptors; Intracellular signal transduction; Activation and regulation of G-Protein coupled receptors. Adenylcyclase, Phospholipase, ion channels, activation of gene transcription.

Textbooks:

1. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell.(2012) Molecular cell biology, Eight Edition, H. Freeman & Company, USA.
2. De Robertis E. D.P. and De Robertis Jr. (1999). Cell and molecular biology, Eight Edition, E.M.F. B.I. Publication Pvt. Ltd., New Delhi.
3. Power, C.B. (2010) Cell Biology, Himalaya Publishing House, Bombay.
4. Nalini Chandar, Susan Viselli, (2022),Lippincott Illustrated Reviews Cell and Molecular Biologyby Publisher: Wolters Kluwer, pp-300.
5. Ganesh Pawar ,Vrushali Hingane,Dr.Sudhakar Gutte,Dr.Karuna Pawar (2020) A text book on Molecular Biology, Kindle Edition,pp-179.

Reference books:

1. Gupta, P.K. (2005) Cell and molecular biology, Second Edition, Rastogi publications, Meerut, India.
2. Charles J. Flickinger, Brown, J.C., Hutachi, H.C. and Ogilive, J.W. (1979) Medical Cell Biology, Sounders Company, Japan.
3. Sivarama Sastri, K.G. Padmanaban and Subramanyan, C. (1994) Text book of Molecular Biology, Macmillan India Ltd., New Delhi.
4. Cooper G.M and Hausman, R. E. (2009) The cell. A Molecular Approach. 5th Edition, Garland Publications, U.K.
5. Paul, A. (2007) Textbook of Cell and Molecular Biology, Books and Allied Publishers Pvt. Ltd., New Delhi.
6. Manjot and Randhawa and S.S.Randhawa (2019) Cell and molecular biology,Vikas publishers and company (PV),pp-200.
7. Kishore R.Pawar and Ashok A. Desai, (2023) Cell biology,NiraliPrakashan,publishers, II nd Edition, pp-130.
8. Bruce Alberts ,Rebecca Heald ,Alexander Johnson ,David Morgan (2022) Molecular biology of cell , 7TH Edition WW Norton & Co,publishers pp-1552.

E-resources:

1. https://www.nicholls.edu/biol-ds/biol155/Lectures/Cell%20Biology.pdf
2. https://www.exploringnature.org/graphics/biology/organelles_info_quiz.pdf
3. http://sciencescpk.pkru.ac.th/images/doc/mad21975_ch03.pdf
4. http://www.csun.edu/~cmalone/pdf360/Ch15-2repairtanspose.pdf

MappingwithProgramme Outcomes*								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

*S -Strong; M- Medium; L–Low

DEVELOPMENTAL BIOLOGY

(Subject Code: 23PZOC22)

Semester: II Core: 6 Credits: 5 Hours: 5

Course objective: To understand the process of gametogenesis, cleavage and gastrulation, embryonic development, extra embryonic membrane and placenta in various animals and human.

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

1. Define the concepts of embryonic development (**K1**).
2. Observe various stages of cell divisions under microscope (**K2** & **K3**).
3. Understand the formation of zygote (**K4**).
4. Differentiate the blastula and gastrula stages (**K4** & **K5**).
5. Learn the distinguishing features of three different germ layers and formation of various tissues and organs (**K4**).
6. Critically assess current scientific findings on topics related to developmental biology (K6)

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

Unit I: Gametogenesis, Fertilization and Cleavage (15 Hours)

Spermatogenesis. Oogenesis. Egg: Polarity and gradient. Morphogenetic factors. Transcription factors. Maternal Gradient. Fertilization: Morphological, Biochemical and Physiological events. Cleavage: Types, patterns and rules. Role of yolk. Cell lineage.

Unit II: Gastrulation and Organogenesis (15 Hours)

Frog Gastrulation: Fate maps, Morphogenetic movements. Metabolic events. Neurulation and formation of primary germlayers. Induction and organizer.Potency, Commitment, specification, competence, determination and differentiation. Organogenesis: Brain, eye, heart and limb in frog.,

Unit III: Role of genes and cytoplasm in development (15 Hours)

Caenorhabditis elegans: Life cycle, cell lineage, cell – cell interactions and polarity, *hox* genes, genetic control and microRNAs. Ascidian: Mosaic development, cytoplasmic factors, mesenchyme and notochord development.

Unit IV: Development of *Drosophila* (15 Hours)

Early development upto hatching, Maternal genes and body axes, polarization of body axes during Oogenesis, Zygotic genes, Pattern formation: pattern of early embryo segmentation; the pair rule genes, segmentation polarity genes and Homeotic selector genes. Terminal genes.

Unit V: Metamorphosis and regeneration (15 Hours)

Frog metamorphosis: Morphological, Physiological and Biochemical changes and causation of metamorphosis in frog. Regeneration: Types, (*Hydra*, salamander and mammalian liver)

mechanism and factors, Polarity and gradient. Wolffian regeneration. Outline of insect metamorphosis

Textbooks:

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.
5. Subramaniam, T. (2011) Molecular Developmental Biology (2nd Edition), Narosa Publishers, India, pp-364.
6. Julia Paxson, Ann fullick (2024) Animal Developmental Biology: Embryos, evolution, and
7. ageing, oxford Biology Prime Foundations,pp-176
8. Kotpal R. L. (2020) Comparative and Developmental Biology,Rastogi Publications pp-372.

Reference books:

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 (3rd Edition), 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.
4. Michael Barresi and Scott , (2023) Developmental Biology ,Thirteenth Edition, pp-880.
5. Rashmi Sharma(2023)Developmental Biology , Anvi Books & Publishers, pp-200.
6. Asha Sharma, (2024) Developmental Biology, RBD Publication, pp-150.
7. Marcel Weber (2022) Philosophy of Developmental Biology by, Cambridge University Press New edition, pp-75 .
8. Reddy E.C, Surendranatha L, Nirmala Jyothi (2016) Developmental Biology,Sbw Publishers pp-130.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	S	S	L	S	M
CO2	S	S	S	S	S	L	S	S
CO3	S	M	S	S	S	S	S	L
CO4	S	S	S	S	S	M	S	S
CO5	S	S	S	M	S	S	S	L

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

CELLULAR AND MOLECULAR BIOLOGY &DEVELOPMENTAL BIOLOGY - PRACTICAL

(Subject code: 23PZOC23)

Semester: II Core: 7 Credits: 2 Hours: 4

CELLULAR AND MOLECULAR BIOLOGY

1. Observation of mitotic stages – in onion root tip
2. Observation of meiotic stages in grasshopper testis
3. Salivary gland chromosome of Chironomus /Drosophila larva.
4. Demonstration of Barr body in human buccal epithelial cells by supra vital staining method
5. Glycerine mount of different kinds of cells (Squamous epithelial cells and goblet cells)
6. Identification of cells in the haemolymph of the cockroach
7. Identifications of cells in Human blood smear

Spotters: Plasma membrane, Mitochondria, Ribosomes, Lysosomes, Endoplasmic reticulum, nucleus, Nucleolus, Golgi complex, Centrioles, Types of chromosomes, Ultrastructure of chromosomes, Cell secretion, DNA double helix, Variants of double helical DNA, Protein synthesis, DNA- Replication, Structure of Lac operon, DNA repair and Cancer.

DEVELOPMENTAL BIOLOGY

1. Mounting of eggs (fish / frog).
2. Observation of mammalian sperm motility.
3. Observation of developmental stages of Drosophila/ House fly and Mosquitoes.
4. Identification of mutant types in Drosophila
5. Chick embryo development - preparation of whole mounts; examination of live embryos - examination of foetal membranes.
6. Regeneration of tadpole tail
7. Effects of iodine on tadpole metamorphosis.
8. Observation of developmental stages in frog
9. Development of brain, eye, ear, limb, heart and urinogenital systems from slides.

Spotters: Frog -T.S. of Testis and Ovary, fertilized egg, first cleavage, 16 cell stage, blastula, gastrula, yolk plug stage, neurula, tadpole Sagittal section showing optic cup; Chick embryo - primitive streak, 26 hours of chick embryo, 36 hours, 48 hours, 72 hours, 96 hours; Types of placenta -Yolk sac, Yolk stalk, Discoidal, Diffuse, Cotyledonary; Teratology-Four legged chick, Double headed shark, Bifid Tail and Anencephalic foetus.

ECONOMIC ENTOMOLOGY - PRACTICAL

(Subject code: 23PZOC24)

Semester: II **Core: 8** **Credits: 2** **Hours: 4**

1. Identify and record the salient features of economically important insect orders (preserved specimens and paper cuttings)
2. Temporary mounting of tarsi (preserved specimens of any insect)
3. Study of mouth parts in insects (Grasshopper, plant bug, mosquito, house fly)
4. Study of sexual dimorphism in insects
5. Sting apparatus –honeybee
6. Preparation of crude kairomone extract of a pest(s)
7. Qualitative profiling of secondary metabolites of pesticidal plant (Neem extract, neem oil and commercial neem formulation).
8. Preparation of emulsifiable concentration of botanical pesticide (neem or pungam oil)
9. Determination of corrected mortality and LC_{50} using SPSS
10. Phytotoxicity of conventional pesticides/ biopesticides (seed germination method)
11. Insect box: Collection, preservation and submission of insects (Representatives of insect orders, Beneficial, Harmful and productive insects)
12. Spotters related to theory

    Harmful insects: Pests - Sap feeders (aphid, mealybug, bugs); Defoliators (lepidopteron); Borers (coleopterans); Soil pest (termites); storage pest (internal and external feeder). Vectors - animal vectors (Mosquitoes, houseflies, horsefly, Cockroaches) and plant vectors (Aphids and plant hoppers).

    Beneficial insects (preserved specimens) – predators (reduviids, dragon and damsel flies, Chrysoperla, lady bird beetle), parasitoids (*Trichogramma*), pollinators (butterflies and wasps)

    Productive insects (preserved specimens): honey bees, mulberry silkworm, eri silkworm, lac insect
13. Mini group project: Collection and model making related to biology of important insects, commercial pesticides, pest control devices.
14. Visits to Agro-ecosystems, Agriculture College/Research Institute.

ECONOMIC ENTOMOLOGY

(Subject code: 23PZOE21)

Semester: II Elective: 3 Credits: 3 Hours: 4

Course objective: Students should acquire a fairly good understanding of the life of insects and their classification.

Course outcomes: At the end of the course the students will be able to

1. Identify commonly available insects and study their distribution and abundance**(K1)**
2. Understand taxonomy, classification and life of insects in the animal kingdom(**K1 & K2)**
3. Know the life cycle, rearing and management of diseases of beneficial insects.(**K2 & K3)**
4. Classify the type of harmful insects, life cycle, damage potential and management of pests including natural pest control.(**K2 & K3)**
5. Recognize insects that act as vectors causing diseases in animals and humans.(**K2 & K4)**
6. Overall understanding of the importance of insects in human life.(**K2 & K6)**

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

Unit I: Overview of insects and insect taxonomy (12 Hours)

Insects and their biological success – Man and insects; Basic concepts in Insect Taxonomy and classification.

Unit II: Beneficial Insects (12 Hours)

Silkworms - types, life history, disease management and rearing methods; Types of honey bees, life history, social organization (colonies and caste system), honey bee care and management of bee hive; Lac insects-life history, laccultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil builders.

Unit III: Destructive Insects (12 Hours)

Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level; Biology of the insect pests - Pests of paddy, cotton, sugarcane, vegetables, coconut and stored grains cereals.

Unit IV: Pest management/Control strategies (12 Hours)

Methods and principles of pest control – Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control; Development and uses of pest resistant plant varieties; Integrated pest management - Concepts and practices.

Unit V: Vector biology (12 Hours)

Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures

Textbooks:

1. Ayyar, L.V. R. (1936) Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi, pp- 528.
2. Vasantharaj David, B. and V.V. Ramamurthy (2016) Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.
3. Ross. H.H. (1965) A Text Book of Entomology, John Wiley & Sons Inc., New York,pp-746.
4. Neetu Kachhwaha (2022) Essentials of Economic Entomology (Volume - 3), AkiNik Publications,pp-226.
5. David B.V , Ramamurthy VV (2016) Elements of Economic Entomology ,8th Edition, Brillion Publishers,pp- 400.

Reference books:

1. Chapman, R.F., S.J. Simpson and A.E. Douglas. (2012) The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
2. Imms, A.D., O.W. Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.
3. Daly, H.V., J.T. Doyen and P.R. Ehrlich. (1978) Introduction to Insect Biology and Diversity. McGraw-Hill Kogakusha Ltd., Tokyo, pp-564.
4. Hill, D.S. (1974) Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.
5. Krishnaswami, S. (1973) Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
6. Mani, M.S. (1982) General Entomology. Oxoford& IBH Publishing Co., pp-912.
7. Wigglesworth, V.B. (1972) The Principles of Insect Physiology, ELBS & Chapman and Hall, London, pp-827.
8. Prasad T.V .(2019) Handbook Of Entomology, New Vishal Publication, Fourth edition,pp-536.
9. Ajay Tiwari, (2021)Objective Entomology, Sankalp Publication,pp-140.
10. Anilkumar B. Pardeshi (2017)General and Economic Entomology ,Oxford book
11. company,pp-252.
12. Tanweer Alam (2020) Elements of Entomology, Jaya Publishers, 1st edition,pp-230.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	M	S	M	S	M	S	M	S
CO2	S	S	M	S	S	S	M	M
CO3	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	M	S	S
CO5	S	S	S	M	M	S	M	L

RESEARCH METHODOLOGY

(Subject code: 23PZOE22)

Semester: II **Elective: 4** **Credits: 3** **Hours: 4**

Course objective: Students understand the basic principle, methodology and applications of widely used instruments in biological sciences.

Course outcomes: Upon the successful completion of the course, student will be able to

1. Understand the implications of GLP (**K1**).
2. Learn the working principles of different instruments (**K2**).
3. Gain the knowledge on techniques of histology and histochemistry (**K2** &**K4**).
4. Acquire knowledge of the basic principle and application of various modules of light and electron microscopy (**K3** &**K5**).
5. Compare and identify new knowledge, establish facts, and test hypotheses, and to solve address issues.
6. Create and standardize more consistent cell culture technique **(K6)**.

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

Unit I: Analytical and Separation Techniques (12 Hours)

Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry, Bomb calorimeter, Atomic absorption spectrophotometer; Isolation and purification of RNA; RFLP and RAPDChromatography - Thin layer and Column chromatography, HPLC, GC and GCMS; Principles and working methods.

Unit II: Histological and Immunological Techniques (12 Hours)

Histology, Histochemistry, Differential fixation and preservation; blocking; embedding; sectioning; staining; histochemical and histomorphological techniques; In *situ* localization by techniques using FISH; Immuno- fluorescence techniques, ELISA, RIA and EMIT.

Unit III: Microscopy (12 Hours)

Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy, Electron (SEM & TEM) Microscopes, Freeze-etch and freeze-fracture methods for electron microscope image processing methods in microscopy

Unit IV: Animal Biotechnology (12 Hours)

Animal cell culture techniques: media preparation, equipments, aseptic techniques, Principles and Applications of tracer techniques in biology, Electrophoresis - AGE and PAGE; PCR and blotting techniques; Centrifugation – principles and types (differential and density gradient).

Unit V: Thesis writing (12 Hours)

Research Problem, Research Design, Developing a Research Plan, Literature survey, e-resources, documentation, Collection of Data, data processing; Parts of a thesis and thesis writing; Research report Presentation; Proof correction - symbols, M.S. word review option and

other tools, plagiarism; Evaluation of a research project; Funding agencies (DST, DBT, UGC, CSIR, ICMR, ICAR, TNSCST) and research proposal writing.

Textbooks:

1. Pearse, A.G. (1968) Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J & A Churchill Ltd, pp-758.Lillie, R.D. (1954) Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.
2. Hoppert, M. (2003) Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.
3. Kothari C. R, (2023)Research Methodology -Methods and Techniques, 5 th edition , New age publications, pp-418.
4. Ranjit kumar (2023) Research Methodology : A Step by Step guide for beginners, 4 th edition,SAGE Publications Pvt. Ltd,pp-366.
5. Sanjay Zodpey, (2024) IAPSMS Textbook Of Comprehensive Research Methodology ,1st Edition ,Jaypee publications ,pp-300.

Reference books:

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.
6. SansanwalD.N (2020) Research Methodology and applied Statistics,Shipra Publications.pp-302.
7. Shaifali Garg , Piyush Mehta,. Ch. Lakshmana Rao ,. Rupesh Roshan Singh (2023) Research Methodology, Book rivers publisher pp-205.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	M	S	M	S	M	S	M	S
CO2	S	S	M	S	S	S	M	M
CO3	S	M	S	S	S	S	S	S
CO4	S	S	S	S	S	M	S	S
CO5	S	S	S	M	M	S	M	L

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

POULTRY FARMING

(Subject code: 23PZOS21)

Semester: II **SEC: 1** **Credits: 2** **Hours: 4**

Course objective: To know basic concepts in poultry farming and breeding and rearing of chicks.

Course outcomes: At the end of the course the students will be able to

1. Gain knowledge of past and present status of poultry farming in our nation **(K1)**.
2. Understand the various practices in poultry farming (**K2**).
3. Know the needs for poultry farming and the status of India in the global market (**K1**&**K2**).
4. Apply the techniques and practices needed for poultry farming (**K3**).
5. Know the difficulties in poultry farming and be able to propose plans against it (**K4**&**K5**).
6. Develop new strategies to increase egg and meat production in order to suffice the high requirements **(K6)**

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

Unit I: Introduction **(12 Hours)**

Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses Marketing, and Economics of poultry.

Unit II: Poultry breeds **(12 Hours)**

Breeds and their selection; Different Types of Poultry Farming Systems – Backyard, commercial, breeder, mixed farming; Choosing commercial layers and broilers; Practical aspects of chick rearing.

Unit III: Nutrition and Feeding **(12 Hours)**

Poultry feed-Nutrient requirements for different stages of layers and broilers, Various poultry diets, Major ingredients for poultry diets, Feeding- appliances and methods.

Unit IV: Diseases **(12 Hours)**

Poultry diseases-Viral **(**Ranikhet diseases), Bacterial (Salmonellosis); Fungal (Aspergillosis), Parasitic (any one), Miscellaneous diseases; Principle of immunity, immunization and control of infectious diseases.symptoms, control and management; Vaccination programme.

Unit V: Management **(12 Hours)**

Management of eggs, chick, beak trimming, breeders, brooders, growers, layers, broilers. 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.

Textbooks:

1. Sreenivasaiah., P. V., (2015) Textbook of Poultry Science.1st Edition. Write & Print Publications, New Delhi 2.
2. Jull A. Morley, (2007) Successful Poultry Management.2nd Edition. Biotech Books, New Delhi"
3. Hurd M. Louis, (2003) Modern Poultry Farming.1st Edition. International Book Distributing Company, Lucknow."
4. Sharma, R. P.et al (2020), Poultry Production in India ,Poultry production Publisher,pp-,240.

Reference Books

1. Leach J.A. (2017). Poultry: Feeds & Nutrition, Medtechpublishers,pp-546
2. Chauhan H.V. S. (2018), Poultry Diseases, Diagnosis ,New Age International PrivateLimited,pp-538
3. Gaylor Blair (2022) Poultry Diseases and Their Remedies; the Cause, Symptoms, andTreatment of all Diseases Known to Poultry Publisher Legare Street Press,pp-102.
4. Das D ,Das B C , Nayak N .(2021) TextBook on Poultry Management , Narendra PublishingHouse,pp-345
5. Dash Dr.Sasadhar, (2020), Poultry Farming , Namya Press Publisher,pp-540
5. Virender Singh .(2021) The Complete Guide of Poultry Farming: Eggs Production, RaisingChickens , Independently Published pp-58.
6. Pavan Kumar, Yadav Dinesh Kumar, Rashmi Kumar, MS Mahesh ,(2024) Handbook ofLivestock & Poultry Production and Management , Narendra Publishing House,pp-300.
7. Grace A. Strong, (2023) Poultry Farming A Beginners' Guide to Poultry Farming,independently. ,pp-34

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	M	S	M	S	S	M	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

EVOLUTION

(Subject code: 23PZOC31)

Semester: III Core: 9 Credits: 5 Hours: 5

Course objective: To understand the concepts, trends and patterns of evolution as well as evolution of selected groups.

Course outcomes: At the end of the course the students will be able to

1. Understand and describe origin of life patterns (**K1** & **K2**)**.**
2. Comprehend the evolutionary forces on adaptation (**K1, K2** & **K3**)**.**
3. Summarize molecular studies with evolution **(K3).**
4. Illustrate natural selection and speciation (**K4**).
5. Analyze the evolutionary changes in selected animals (**K4** &**K5**).
6. Create new concepts in the field of population genetics **(K6)**.

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

Unit I: Origin of cells and evolutionary thoughts (15 Hours)

Origin of biomolecules, chemical and biological evolution of life; origin of prokaryotes and eukaryotes, concepts of Oparin and Haldane, experimental evidences of Urey-Miller; Lamarckism, Darwinism-natural selection, mutation theory and modern synthetic theory.

Unit II: Evolutionary history and Palaentology (15 Hours)

Evolutionary time scale: eras, period, and epoch; Major events in the evolutionary time scale; Physical and cultural evolution of Man. Origin of unicellular and multicellular organism. Fossils (museum specimens)

Unit III Molecular phylogeny (15 Hours)

Methods of molecular evolution studies; Principles of molecular evolution studies; Molecular clock, origin of new gene functions; phylogenetics and future prospects of evolutionary biology; Gene duplication and divergence.

Unit IV: Patterns of evolution (15 Hours)

Speciation: Allopatricity and Sympatricity, Sequential and divergent evolution, isolating mechanisms; micro and macro evolution; Adaptive radiation, Convergent evolution. Mimicry and coloration- Batesian and Mullerian mimicry. Co-evolution, migration, navigation, domestication and behavioral changes of human being.

Unit V: Population genetics (15 Hours)

Gene pool, gene frequency, Hardy-Weinberg law. Natural selection in action, Variation – pre-adaptation and post adaptation; normalizing, directional and diversifying selection; Group selection, Kin selection, Reciprocal altruism.

Textbooks:

1. Veer BalaRastogi. (2015) Organic Evolution, Medtech, New Delhi.
2. Verma, P.S. and Agarwal, V.K. (1998) Concept of Evolution, Chand and Company Ltd., New Delhi.
3. SanjibChattopadhyay, (2008) Life Evolution, Adaptation Ethology, ArunabhaSen, Kolkatta. Emlen D.J (2020),Evolution Making Sense Of Life 3rd Edition,Springer/Macmillan Publishesr,pp-.752
4. Robin Dunbar (2020) Evolution: What Everyone Needs to Know Oxford University Press,pp-288.
5. Tripurari Mishra (2023) Evolutionary Biology with Practical, First edition, Mahaveer Publications,pp-308.

Reference Books:

1. Brian K. Halland BenediktHallgrímsson. (2015)Strickberger Evolution, Fourth Edition, Jones & Bartlett publishers, Canada.
2. Dobzhansky,T, Ayala,J., Stebbins, G. and Valentine, W. (1973) Evolution, Surjeet Publication, New Delhi.
3. Charles W. fox & Wolf. (2006) Evolutionary genetics, Oxford University press, New Delhi.
4. Peter Stiling, (2002) Ecology Theories and Applications, Fourth edition, Prentice Hall, India.
5. Mohan P. Arora and Arora, H. (2013) Organic evolution, Himalaya Publishing House, Mumbai.Mark Ridley (2020), Evolution,Oxford University Press,pp-472
6. John Adrian eRoy (2017)The Science of Life and Evolution XLIBRIS Publishers, pp-192.
7. Kishore R. Pawar,and Ashok E. Desai (2022) Evolutionary Biology,first edition , Nirali PrakashanPublishers,pp-116.
8. Eden Cole (2022).Understanding Evolutionary Biology , States Academic Press,PP-154

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

ANIMAL PHYSIOLOGY

(Subject code: 23PZOC32)

Semester: III Core: 10 Credits: 5 Hours: 5

Course objective: To expound the structure, mechanism and physiological functions of different organ systems.

Course outcomes: At the end of the course the students will be able to

1. Understand and remember the basic constitution of various systems (**K1** & **K2**).
2. Describe and comprehend the structure and functions of organs (**K3** & **K4**).
3. Illustrate the structure and functions of nerves, muscles, phono and photoreceptors (**K4** & **K5**).
4. Compare the functions of reproductive and endocrine organs (**K4**).
5. Interpret functions of endocrine organs **(K5)**.
6. Integrate the role of hormones in regulating human physiology (**K6**)

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

Unit I: Nutrition and Digestion (15 Hours)

Nutrition: Composition of food, Biological importance of carbohydrate, protein, fat, minerals and vitamins; Calorific value, daily requirements, low and high intake implications.

Digestion: Digestive system - general structure of alimentary canal and digestive glands, physiology of digestion and gastrointestinal hormones.

Unit II: Respiration and circulation (15 Hours)

Respiration: Respiratory organs and pigments in animals. Structure of human lungs and mechanism of respiration; Transportation of gases;Acid base balance (buffer system).

Circulation: Types of heart (neurogenic and myogenic); Structure of human heart and blood vessels, Blood - volume composition and functions; Heart beat, cardiac cycle, ECG; circulation of blood, haemodynamics and blood pressure; Haemostasis; Haemopoiesis; Angiogram.

Unit III: Excretion and Endocrine system (15 Hours)

Excretion: Excretory organs, structure of kidney, physiology and mechanism of excretion – adaptations of excretion to the environment - Excretory products.

Endocrines: Endocrine glands - Feedback regulation - Pituitary – gonadalaxis - Role of reproductive hormones - gamete formation; fertilization; embryonic development; parturition; lactation; neuroendocrine regulation**.**

Unit IV: Nerves, Muscles and Sense Organs (15 Hours)

Nervous system: Central nervous system - Structure of Human brain and spinal cord; peripheral nervous system; Types and structure of neurons; neuronal and sympathetic transmission, action potential and neurotransmitters.

Muscles: Ultra structure-types and composition; Neuromuscular junction.

Sense organs: Gustatory, olfactory, mechano, photo and phono receptors – structure and functions; bioluminescence.

Unit V: Reproduction and Homeostasis (15 Hours)

Reproductive system: Structure of Human reproductive organs – puberty, menstrual cycle, menopause.

Homeostasis: Endothermy and physiological mechanism of regulation of body temperature, Physiological adaptation to osmatic and ionic stress; mechanism of cell volume regulation - Osmoregulation in aquatic and terrestrial environments. Physiological response to oxygen deficient stress.

Textbooks:

1. Rastogi, S.C. (2001) Essentials of Animal Physiology, Third Edition, New Age International Publication, New Delhi.
2. William S. Hoar. (1983) General and Comparative Physiology, Prentice Hall Pvt. Ltd., New Delhi.
3. Rastogi S.C. (2019) Essentials of Animal Physiology ,New Age International Publishers,PP- 596.
4. Diwakar mishra (2023) Animal Physiology: Life Sustaining Systems, Mahaveer Publications,PP-424.
5. Kailash Choudhary and Ram Prakash Saran (2021) Animal Physiology 1st, IFAS Publications,PP-460.

Reference books:

1. Knut Schmidt-Nielsen.(2008) Animal Physiology: adaptation and environment, Fifth Edition, Cambridge University Press.
2. Schmidt – Nielson, K. (2002) Animal Physiology – Adaptation and Environment, Cambridge Press, Cambridge.
3. Hoar, W.S. (2003) General and Comparative Animal Physiology, Prentice Hall of India.Nedu (2021) Anatomy & Physiology Made Easy ,NEDU Publishiers,PP-300.
4. Bhabesh Mili (2022) Multiple Choice Questions in Animal Physiology ,Brillion Publishing,PP-206.
5. Arora M.P (2018)Animal Physiology For Bsc and Msc,Himalaya Publishing House Pvt.Ltd.pp -260.
6. Saijoti .U. (2023) Animal Physiology and Animal Behaviour, SIA Publishers & Distributors Pvt Ltd ,pp-192.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

EVOLUTION & GENETICS- PRACTICAL

(Subject code: 23PZOC33)

Semester: III CORE: 11 Credits: 2 Hours: 4

EVOLUTION

1. Adaptive modifications in feet, beaks and wings of birds.
2. Study of ecological morphology of animals.
3. Embryological evidence for evolution
4. Serial homology in appendages of prawn
5. Study of human skull
6. Study of fossils (museum specimens)
7. Comparative study of Animal Skull (pig, horse, dog and deer)
8. Osteology of vertebrates (museum specimens)
9. Visit to Athichanallur, Ariyaloor fossil site and Govt. Museum

Spotters: Homologous organs, analogous organs and vestigial organs; Mesozoic reptiles - connecting links – living fossils; Fossils: Mollusca- Gastropod (Tertiary) and Ammonite (Jurassic).

GENETICS

1. Study of phenotypic variation in Drosophila
2. Estimation of calcium in egg shell by EDTA method
3. Verification of Mendel's law – monohybrid and dihybrid crosses using coloured beads
4. Hardy-Weinberg's equilibrium with complete selection (using coloured beads).
5. Hardy-Weinberg's equilibrium with partial selection (using coloured beads).
6. Quantitative inheritance - Serration in neem leaves, Height and weight.
7. Variation in thumb impression

Spotters: Multiple alleles (Blood grouping), Complete linkage in Drosophila, Haemophilia, Sickle cell anaemia, Rh Factor (Erythroblastosisfoetalis), Albinism, Klinefelter's syndrome, Turner's Syndrome, Down's Syndrome, Lytic and lysogenic cycle, Conjugation, Transformation, Transduction and sexduction.

ANIMAL PHYSIOLOGY– PRACTICAL

(Subject code: 23PZOC34)

Semester: III **Core: 12** **Credits: 2** **Hours: 4**

1. Enumeration of digestive enzymes profile in cockroach
2. Salt loss in a fresh water fish
3. Salt gain in a fresh water fish
4. Effect of salinity on opercular movement of a freshwater fish
5. Effect of temperature on opercular movement of fish
6. Effect of temperature on human salivary amylase activity
7. Estimation of oxygen consumption rate by the given fish
8. Constituents of human blood (RBC, WBC, Platelets)
9. BMI analysis using height and weight
10. Estimation of haemoglobin
11. Haemin crystals
12. Enumeration of blood platelets
13. Estimation of blood glucose during fasting and PP.
14. Urate crystals
15. Uric acid crystals –Bird, Rat, Fish

Spotters: Human brain, heart, lungs, eye, tongue, ear, Pancreas, Kidney, circulatory system, digestive system, Pituitary gland, Thyroid gland, Parathyroid gland, Adrenal gland, L.S. of testis and Ovary, ECG, Oxygen dissociation, Endocrine glands, Menstrual cycle, Gastro intestinal hormone action and Types of muscles.

GENETICS

(Subject Code: 23PZOE31)

Semester: III Elective:5 Credits: 4 Hours:4

Course Objective: To study hereditary biology, mechanism involved in hereditary diseases and disorders and also to know the fundamental processes of life.

Course outcomes: At the end of the course the students will be able to

1. Define the principles of modern genetics**.(K1)**
2. Explain concepts, methods and applications of gene mapping. **(K2)**
3. Demonstrate the basic and applied genetics of microbes and human. **(K3)**
4. Analyse types, mechanism and implications of mutation. **(K4)**
5. Evaluate genetic disorders and importance of genetic counselling. **(K5)**
6. Integrate genetic methods with agriculture, aquaculture, animals and human welfare. **(K6)**

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

Unit I : Modern genetics and its principles (12 Hours)

Eukaryotic genome –C-value paradox, Repetitive DNA, General concept of a gene, Gene families, Non-coding genes; DNA polymerases, RNA polymerases; Somatic or mitotic crossing over, germinal or meiotic crossing over.

Unit II: Gene mapping methods (12 Hours)

Complete and incomplete linkage, Linkage maps, LOD score for linkage testing, Tetrad analysis, Mapping with molecular markers, Mapping by using somatic cell hybrids; Extra chromosomal inheritance- Mitochondrial inheritance, Kappa particles.

Unit III: Microbial and Human Genetics (12 Hours)

Microbial genetics-Methods of genetic transfers – transformation, conjugation, Transduction and sexduction, mapping genes by interrupted mating; Human genetics- Pedigree analysis, genetic disorders (Brachydactyly, Huntington's chorea, Sickle cell anemia); Genetic counseling - eugenics, euthenics and euphenics.

Unit IV: Mutation (12 Hours)

Mutation -Types (Spontaneous, Induced, lethal, conditional, biochemical), causes, loss of function, gain of function, Germinal verses somatic mutants, insertional mutagenesis; Quantitative genetics - Polygenic inheritance, Types of quantitative traits (continuous, meristic and threshold); examples (skin colour and height in humans), Mapping of Quantitative trait loci (QTL mapping).

Unit V: Applied genetics (12 Hours)

Animal Selective Breeding; Crime and Law DNA Finger Printing; Agriculture (food production), Disease prediction (colour blindness and dwarfism), Aquaculture (breeding and production)

Textbooks:

1. Benjamin Lewis, (2007) Genes IX, Jones and Bartlett Publishers, U.S.A.
2. Monroe W. Strickberger, (2012) Genetics, Third Edition, Prentice Hall of India, Pvt.Ltd,India.
3. Dr. P S Verma & Dr. V K Agarwal (2022) Genetics: Library Edition,S Chand and Company ltd,pp-1312.
4. Singh B.D.(2022) Fundamentals of Genetics,Medtech Science PressPublishers,pp-710.
5. Ricki Lewis (2020) Human Genetics 12thEdition ,McGraw Hill,pp-480.

Reference Books:

1. Cummings, K. and William S. Klug (2016) Concepts of Genetics. 11th Edition, Pearson Education India, 896 pp.
2. Twyman, R. (2005) Gene Transfer to Animal cell, Taylor & Francis Group, CT, USA, 256 pp.
3. Gurbachan Miglani,(2015) Essentials of Molecular Genetics, Alpha Science International Ltd., Oxford, United Kingdom.
4. Tamarin, R.H. (2002) Principles of Genetics, Tata McGraw Hill Publishing Company, New Delhi.
5. Singh B. D. (2023) Genetics Cytogenetics , 2nd Edition ,Medtech Science Press-pp230.
6. Yogesh Ashok Sontakke (2021) Principles of Clinical, Jaypee Brothers Medical Publishers,pp-166.
7. Mamata Behera, Rinny Swain, Aditya Pratap Singh (2024) A Practical manual on fundamentals of Genetics ,Bigfoot Publications.pp-75.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	S	S	S	S	S	S
CO2	S	S	S	S	S	M	M	S
CO3	S	S	S	M	S	S	M	S
CO4	S	S	S	M	L	M	S	S
CO5	S	S	S	S	M	S	S	S
CO6	S	S	S	M	L	M	S	M

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

ANIMAL HUSBANDRY

(Subject code: 23PZOS31)

Semester: III SEC: 2 Credits: 3 Hours: 4

Course objective: To make aware of the importance of animal husbandry for income generation and to create self-employment venture.

Course outcomes: Upon completion of this course, students would be able to

1. Gain basic knowledge on animal farming technology (**K1**).
2. Understand the various practices in dairy farming (**K2**).
3. Know the needs for dairy farming and the status of India in global market (**K2**&**K3**).
4. Apply the techniques and practices needed for poultry farming (**K1**, **K2**&**K3**).
5. Know the difficulties in dairy, poultry, goat and rabbit farming and be able to propose plans against it (**K5**&**K6**).
6. Augment production of milk, meat, egg, live stock breeds, and other animal bi-products **(K6)**

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

Unit I : Introduction (12 Hours)

Animal husbandry: Definition - Scope of Animal husbandry in India; Classification of common domestic animals- non ruminants and ruminants; breeding of farm animals - artificial insemination

Unit II : Dairy farming (12 Hours)

Scope of dairy farming - types of cattle breeds; dairy products; nutritive value of milk; Lactometer

Unit III : Poultry farming (12 Hours)

Poultry farming in India; Common poultry breeds in India; Nutritive value of eggs; sexing; construction of poultry house; rearing of broilers; poultry diseases.

Unit IV : Goat and sheep farming (12 Hours)

Breeds of Indian goats and sheep; Exotic breeds of goats and sheep; Nutrition requirements; diseases and vaccination (disease symptom, treatment and vaccination)

Unit V : Rabbit farming (12 Hours)

Scope of rabbit farming; types of breeds; nutritional requirement; farm management

Textbooks:

1. Banerjee, G.C. (2010). Text book of animal husbandry , Oxford & IBH Publishing company Pvt. Ltd, New Delhi, India
2. Arumugam, N., Jeyasurya, Nair, N.C., Soundarapandian, N., THangamani, A., Narayanan, L.M., Leelavathi, S., Murugan, T., Prasanna Kumar, S., Johnson Rajeshwar, J. and Ram Prabu, R. (2013). Economic zoology, Saras publication, Nagerkoil. Harish

Kumar Verma and Jaswinder Singh (2023)A Text Book of Veterinary and Animal Husbandry ,New Delhi Publishers,pp-590
3. Harilal, and Sathish (2015) Organic Animal Husbandry, serial Publishing House,pp-66.
4. Singh, Chandrama (2021) Textbook Of Animal Husbandry,Bio Green books Publishers,pp-256.

Reference Books :

1. P.N. Bhat ,M.P. Yadav ,(2018) Animal Husbandry: Research, Education and Development, Scientific publishers (India),pp-280.
2. Chetraj Upreti, Dr. Niraj Baskota, Sujaya Upreti (2020) Introductory Animal Husbandry, Heritage Publishers & Distributors Pvt.Ltd,pp-304.
3. Chandrama Singh (2023)Handbook Of Animal Husbandry, Bio Green books Publishers,pp-256.
4. Titus Miracle (2024) Animal Husbandry : How to start Animal Husbandry Business a Complete Guide,Independently published ,pp- 52.
5. SandeepTomar (2011). Basic operations of Animal husbandry. Oxford Publishers, New Delhi.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	M	S	M	M	S	S	M	S
CO2	S	M	L	S	M	S	M	M
CO3	M	M	L	S	L	S	M	L
CO4	S	S	L	S	L	S	M	L
CO5	S	S	M	L	M	S	M	S

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

STEM CELL BIOLOGY

(Subject code: 23PZOS32)

Semester: III SEC:3 Credits: 3 Hours-4

Course objectives: To outline the basics of stem cells and its applications for betterment of the society.

Course outcomes: At the end of the course the students will be able to

1. Learn the properties of stem cells **(K1)**
2. Understand the basic knowledge of stem cells and their origin **(K1 & K2)**
3. Differentiating the embryonic and adult stem cells**(K3 & K4)**
4. Understand and apply the current stem cell therapies for their research **(K3 & K5)**
5. Explain the ethical concern and difficulties in stem cell therapies **(K5&K6).**
6. Propose methods of diagnosis, treatment, and prevention of multiple human diseases**(K6)**

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

UNIT I : Introduction to stem cell biology (12 Hours)

Introduction to stem cell biology: Stem cell definition, origin and hierarchy, stem cell properties, Identification and Characterization, potency and differentiation, niche of stem cell, overview of different stem cell types (embryonic stem cells, adult stem cells and induced pluripotent stem cells)

UNIT II : Embryonic stem (ES) cell (12 Hours)

Embryonic stem (ES) cell: Characterization and properties of ES cells , pluripotency and self-renewal of ES cells; molecular mechanisms regulating pluripotency and maintenance of the stem state, progressive differentiation of ES cells into ectoderm lineage organs (skin, brain and nerve), mesoderm lineage organs (heart, kidney, muscle, bone and blood), and endoderm lineage organs (lung, liver, stomach, pancreas and intestine).

UNIT III : Adult stem cells (12 Hours)

Adult stem cells: Mesenchymal stem cells (MSCs) - sources, properties (plasticity, homing and engraftment), potency and characterization; Haematopoietic stem cells (HSCs) - sources, properties, potency and characterization; steps involved in production of induced pluripotent stem cells (iPSCs); role of Yamanaka factor in iPSCs.

UNIT IV : Stem cell and aging (12 Hours)

Stem cell and aging: aging theory; cell cycle; telomere and telomerase; senescence of stem cell; role of stem cell in aging; tissue repair and regeneration of adult stem cell.

UNIT V : Current stem cell therapies (12 Hours)

Current stem cell therapies: Advantages and disadvantages of ES cells and adult stem cells (MSCs and HSCs) therapy; Ethical concern on stem cell therapy; current stem cell therapy for

various diseases; clinical outcome of stem cell therapy; state of clinical trials in adult stem cells for various diseases.

Text Books :

1. Quesenberry, P.J., G.S. Stein, B. Forget and S. Weissman. (2001) Stem Cell Biology and Gene Therapy, Wiley Publishers, pp-584.
2. Sell, S. and Totowa, N.J. (2004) Stem Cells Handbook, Humana Press, pp-534.
3. Sullivan, S., C. A. Cowan and K. Eggan. (2007) Human Embryonic Stem Cells: The Practical Handbook, Wiley Publishers, pp-424.
4. Battler, A., and Leo, J. (2007) Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Springer Publication, pp-422.
5. Gian Paolo Bagnara, Laura Bonsi, Francesco Alviano (2020) Stem Cells, SocietàEditriceEsculapiopublisher ,pp-304.
6. Jonathan M. W. Slack (2018) The Science of Stem Cells , Wiley-Blackwellpublishers,pp-272.

Reference books :

1. Kiessling, A.A. (2006) Human Embryonic Stem Cells (Second Ed.), Jones &Barlett Publishers. 2. Lanza, R. and A. Atala. (2005) Essentials of Stem Cell Biology. Academic Press, pp712.
2. Turksen, K. (2004) Adult Stem Cells.Humana Press, Inc, pp-429.
3. Lanza, R. et al. (2004) Handbook of Stem Cells: Embryonic/Adult and Fetal Stem Cells (Vol. 1 & 2). Academic Press, pp-1626.
4. Institute of Medicine, (2002). Stem cells and the future of regenerative medicine. National Academy Press, pp-112.
5. Marshak, D., R.L. Gardener and D. Gottlieb. (2001) Stem Cell Biology, Cold Spring Harbour Monograph Series, 40, pp-550.
6. Booth, C. (2003). Stem Cell Biology and Gene Therapy, Cell Biology International, Academic Press.
7. Steven Jackson and Steven T. Duff (2022) Stem Cells The Future Of Health Restoration: What Stem Cells Are The Effects And Benefits ,pp-58.
8. Ian Cole (2017) Essentials of Stem Cell Biology, Larsen and Keller Education,pp-213.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	M	S	M	S	M	S	M	S
CO2	S	S	M	S	S	S	S	S
CO3	S	M	S	S	S	S	M	L
CO4	S	S	S	S	S	M	M	S
CO5	S	S	S	M	M	S	S	S

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

INTERNSHIP

Semester : III **Sub. Code: 23PZOI31** **Credits: 2**

- All PG students will undergo internship during the summer holidays of the First year after completing II semester.
- Two credits will be given for internship.
- Minimum Days: 30
- Minimum working time per day: 3 Hrs. & Maximum working Time: 5 Hrs.
- The places of internship can be government offices, Panchayats, MP, MLA offices, private institutions, companies, production units etc.
- The HoD of the departments will give a letter of introduction to each student.
- The students will identify the company / institution for internship.
- The students will be divided equally based on the number of professors available in the departments. Each professor will serve as a guide to the assigned students.
- The students will finalize the institutions / companies for the internship in consultation with the guides.
- The students shall maintain a work diary which will be countersigned by the managers / authorities of the company in which the students do the internship on daily basis.
- The work diary, Work completion certificate obtained from the company and a comprehensive report on the learning outcomes will be submitted to the guides at the end of the internship.
- Viva will be conducted based on the experience of the internship in the month of August. The guide will be the internal examiner and another faculty from the same department will serve as the external examiner.

IMMUNOLOGY AND MICROBIOLOGY

(Subject code: 23PZOC41)

Semester: IV Core: 13 Credits: 4 Hours: 4

Course objective : To provides cells, and organs involved in immunity of animals and also to provide an overview of the human parasites, vectors and their diseases; host-pathogen interactions and laboratory diagnostic methods.

Course outcomes: At the end of the course the students will be able to

1. Remember the basic classification and the role immune system (**K1**).
2. Understand the fundamentals of immune system (**K2**).
3. Demonstrate immune response of various parasitic infections (**K3**).
4. Summarize microbial classification and their economic importance (**K4** &**K5**).
5. Explain the inevitable role of microbes in human life (K5)
6. Develop microbial products of industrial and medical importance (**K6**).

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

Unit I: Immune System (15 Hours)

Cells of the immune system: B lymphocytes, T lymphocytes, Macrophages, dendritic cells, NK cells, Null cells, Cytokines, Lymphokines and Chemokines; Antigen-Definition, Classification and characteristic features; Antigenic determinants and their types; Immunoglobulins-structure and functions; Lymphoid organs-Primary and Secondary lymphoid organs; Lymphatic tissues - Peyer's patches and Kupffer cells, MALT, GALT and BALT.

Unit II: Immunity and its aspects (15 Hours)

Innate and Adaptive immunity - Active, Passive, Natural, artificial immunity; MHC-Structure, classes and functions; Antigen antibody interactions; Monoclonal antibodies; Complement-Complement activation in Classical, alternate and Lectin pathway - mode of activation, Biological function.

Unit III: Hypersensitivity, Autoimmunity disorders and Transplantation (15 Hours)

Hypersensitivity-Brief accounts on type I, II, III and IV reactions. Autoimmunity: Organ specific AID and non-organ specific AID; Immunodeficiency-Deficiency of T and B lymphocytes, combined immune deficiencies, deficiency of complement and phagocytic system; Transplantation-Allograft rejection, mechanism of graft rejection.

Unit IV: Microbes and role of microbes in human life (15 Hours)

Morphology and General characters of bacteria, fungi, viruses, bacteriophages, cyanophages mycoviruses, actinomycetes, mycoplasma, archeobacteria, autochthonous microbes and rickettsiae. Bacterial genetics-Methods of genetic transfers-transformation, conjugation and transduction, Mapping genes by interrupted mating, fine structure of analysis of genes; Bacterial Physiology-Growth yield and characteristics, strategies of bacterial cell division; Microbes on human life (contact, infection and diseases).

Unit V: Applications of immunology and microbiology (15 Hours)

Applications of immunology and immune techniques - immune therapies, immunization and vaccine production, precipitation reaction, agglutination reaction, radioimmunoassay, ELISA Applications; Fermentation products - penicillin and vitamin B_{12};Bio-fertilizers and biopesticides; Role of microbes in biogas production and pollution management; Economic importance of bacteria with special reference to industry and medicine.

Textbooks:

1. C. Vaman Rao. (2011). Immunology. 2nd edition. Narosa Publishers. 692 pages.
2. Ajit Banerjee, Nirmalya Banerjee. (2008). Fundamentals of Microbiology and Immunology, 2nd edition, New Central Book Agency. 880 pages.
3. Ashim K. Chakravarty. (2006). Immunology and Immunotechnology, Oxford University Press. 592 pages.
4. R. Ananthanarayan, CK Jayaram Paniker, Reba Kanungo, Sonal Saxena. (2022). Ananthanarayan and Paniker's Textbook of Microbiology. 12th edition. Universities Press. 672 pages.

Reference books:

1. Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Peter J. Delves. (2017). Roitt's Essential Immunology 13th edition. Wiley-Blackwell. 576 pages.
2. Jenni Punt, Sharon Stranford, Patricia Jones, Judith A. Owen. (2018). Kuby Immunology. 8th edition, W. H. Freeman. 944 pages.
3. F. H. Khan. (2009). Elements of Immunology, Pearson Education. 508 pages.
4. R. C. Dubey, D. K. Maheshwari. (2013). A Textbook of Microbiology. 4th edition. S. Chand Publishing. 1056 pages.
5. Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton. (2017). Prescott's Microbiology. 10th edition. Mc-Graw Hill. 1104 pages.
6. G. Tortora, B. Funke, C. Case, D. Weber. (2018). Microbiology: An Introduction, 13th edition. Addison-Wesley Publisher. 960 pages.
7. Michael J. Pelczar, E.C.S. Chan, Nobel R. Krieg. (2023). Microbiology. 5th edition. Affiliated East West Press Private Limited. 918 pages.
8. Subhash Chandra Parija. (2012). Textbook of Microbiology and Immunology, 2nd edition, Elsevier. 684 pages.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	M	S	M	S	S
CO2	S	S	M	M	L	S	S	S
CO3	S	M	M	L	M	S	L	L
CO4	M	M	S	S	M	L	L	S
CO5	M	S	S	M	S	M	L	M

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

AQUACULTURE

(Subject code: 23PZOC42)

Semester: IV Core: 14 Credits: 4 Hours:4

Course objective: To familiarize the knowledge on fish pond construction, management, culture, feeding, breeding and disease control of fin and shell fishes.

Course outcomes: At the end of the course the students will be able to

1. Define basic principles and scope of aquaculture (**K1)**
2. Describe construction and management of fish ponds (**K2)**
3. Apply appropriate preparation and management practices in the pond(**K3)**
4. Outline fish nutrition and breeding technology (**K4)**
5. Summarize various components of fish genetics (**K5)**
6. Develop strategies to prevent and treat fish diseases.(**K6)**

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

Unit I: Pond construction and management (15 Hours)

Scope and principle of aquaculture - Fish pond construction: Criteria for site selection, types of ponds, construction and conditioning of pond, water quality analyses, pond maintenance and management.

Unit II: Patterns of aquaculture (15 Hours)

Fresh water - Monoculture-culture of Tilapia; Composite fish culture, integrated fish farming and ornamental fish culture; Coastal-Traditional and modern methods, culture of marine prawns, edible and pearl oysters; culture of sea weeds.

Unit III: Feeding, breeding and rearing technology (15 Hours)

Culture of live feed organisms - *Artemia*, rotifers - Artificial feed - types, formulations and preparation. Induced spawning - use of natural and synthetic hormones, artificial fertilization; seed production, rearing of hatchlings, post larvae, fry and fingerlings.

Unit IV: Fish genetics (15 Hours)

Genome and genomics of fishes; Selective breeding- Hybridization, androgenesis, gynogenesis, induction of ploidy; Gene manipulation-sex reversal; Transgenic fishes; Cryopreservation.

Unit V: Diseases diagnosis and management (15 Hours)

Ecto- and endo-parasites; Bacterial, fungal, EUS and viral diseases - agents, causes, symptoms, control and preventive measures; vaccines and chemotherapy, resistant strain production; Environmental factors and disease spreading; Consequences of consumption of diseased fishes.

Textbooks:

1. R. K. Rath. (2011). Fresh water Aquaculture. 3rd edition. Scientific Publishers. 587 pages.
2. B. Ahilan. (2013). Textbook on Freshwater Aquaculture. Daya Publishing House. 244 pages.
3. S. S. Khanna, H. R. Singh. (2014). Textbook of Fish Biology and Fisheries. 3rd edition. Narendra Publishing House. 610 pages.
4. K. Karal Marx. (2021). Fish Genetics and Breeding. Narendra Publishing House.

Reference books:

1. ICAR. (2006). Handbook of Fisheries and Aquaculture. Indian Council of Agricultural Research. 755 pages.
2. A. S. Ninawe, G. D. Khadkar. (2010). Nutrition in Aquaculture, Narendra Publishing House. 432 pages.
3. S. K. Dubey, Bandana Ghosh. (2012). Fish Biotechnology, Wisdom Press. 316 pages.
4. M. R. Saravanan, K. L. Santhanam. (2008). Introduction to Encyclopaedia of Fishery Science and Technology, Vol. 2: Fish nutrition and biochemistry; Vol. 6. Inland and freshwater aquaculture; International Scientific Publishing Academy.
5. W. S. Lakra, S. A. H. Abidi, S. C. Mukherjee, S. Ayyappan. (2008). Fisheries Biotechnology, Narendra Publishing House. 240 pages.
6. K. P. Biswas. (2007). Prevention and Control of Fish and Prawn Diseases. Narendra Publishing House. 222 pages.
7. V. Sundararaj, B. Srikrishnadhas. (2000). Cultivable Aquatic Organisms. Narendra Publishing House. 175 pages.
8. V. G. Jhingram. (1997).Fish and Fisheries of India. 3rd edition, Hindustan Publishing Corporation. 751 pages.
9. T. L. S. Samuel, S. Felix. (2020). Fish Genetics and Breeding. Daya Publishing House.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	S	S	M	S	S	S	M	S
CO2	S	S	M	M	S	S	M	M
CO3	S	M	S	M	S	S	M	M
CO4	S	M	S	M	S	S	M	M
CO5	S	M	S	M	S	S	M	M

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

IMMUNOLOGY AND MICROBIOLOGY - PRACTICAL

(Subject code: 23PZOC43)

Semester: IV CORE: 15 Credits: 2 Hours: 4

1. Antibacterial assay using disc diffusion method
2. Separation of Lymphocytes
3. Single Radial immunosorbent technique
4. Estimation of viral load in blood samples using haemagglutination test
5. Solid and Liquid Culture media preparation
6. Isolation of bacteria - serial dilution technique
7. Plating techniques
8. Motility of microorganism (Hanging drop method)
9. Gram staining method- Identification of bacteria
10. Demonstration of Western blotting and Southern blotting technique.
11. Separation of lymphocytes from whole blood
12. Separation and Identification of T and B cells.
13. Demonstration of Mast cells.
14. Cell culture demonstration
15. Counting of Animal cells
16. Cell viability test
17. Demonstration of immune electrophoresis
18. ELISA –Demonstration
19. PCR-demonstration

Spotters: Immunology: lymphoid organ- thymus, spleen, lymph node, bursa of fabricius, peyer's patches, Macrophages, Natural killer cells, Immunoglobulin, Phagocytosis, Antibiotics, Recombinant vacine, Edible vaccines, Elisa, Mucosa associated lymphoid tissue, Vaccination schedule, monoclonal antibiotics.

Microbiology: Pure culture techniques, Colony appearance, Culture characteristics, Anthrax, Streptococci, *Clostridium tetani*, *Vibrio cholerae*, Morphology of virus particles, Hepatitis B virus, HIV, Bacteriophage, Candidiasis, Dermatophysis, Growth curve, Biochemical events of inflammation and Microbial sources of antibiotics

PROJECT WITH VIVA VOCE

(Subject code: 23PZOC44)

Semester: IV Project Credits: 7 Hours: 10

Course objective: To promote original thinking, insemination of knowledge, modulation and innovation of thought, as an exercise, in order to transport the young minds to the expanding horizon of their chosen area of knowledge and transform them into knowledge generators.

Process and dissertation frame work: All the students must undertake dissertation work at the final semester (IV semester). Lot system will be followed for allotting students under the faculty from the Zoology Department at St. Xavier's College to work on the dissertation. The topic of research should relate to Zoology that the student intends to undertake. This process includes:

a) The conceptualization of the independent research that will comprise the dissertation,
b) The preparation of and satisfactory defense of the dissertation proposal,
c) The collection, analysis and interpretation of data,
d) Presentation of findings in the dissertation format and oral defense of the dissertation.

Dissertation activity must be completed within the prescribed time frame for the semester.

Submission, chapters and format of the report: Candidates must submit three copies of the report duly signed and endorsed by the Head and the Guide to the Head. Following is a brief guideline for the sections / chapters in the report and the formatting of the report. The report will have three main parts:

a. Initial Pages–in the following sequence.
   i. Title Page
   ii. Certificate from the guide and declaration by the candidate
   iii. Endorsement by the Head of the Department
   iv. Acknowledgement.
   v. Table of Contents
   vi. List of figures, photos, drawings, tables etc.
   vii. List of abbreviations
   viii. Abstract
b. Main body of the report consists of i.) Introduction with objectives, Background information (Literature review), ii.) Methodology, iii) Results (Data Analysis and Findings) and discussion, iv.) Conclusions Summary, v.) Recommendations and vi.) Citations (references)
c. Appendices (if any)

The system of evaluation shall be as follows:

1. Project work would be assigned at the beginning of the IV Semester to enable students to initiate work on the same.
2. The candidate should submit: Tentative title, review of literature, objectives and proposed methodology during the first week of the semester IV. This component would be evaluated for 25 marks.
3. In addition, 30 and 60 working days, the candidate should submit results and these components would be evaluated for 25 marks each
4. There shall be a closed*viva-voce* examination at the end of Semester IV on the Dissertation that shall be evaluated by External and Internal examiners.
5. Project report / dissertation shall be presented by Power point.

Dissertation: 75 marks (25 + 25 + 25 – evaluated by the guide and another faculty member from the department**);** *Viva voce* examinations: 25 marks.

AQUACULTURE AND ECOLOGY - PRACTICAL

(Subject code: 23PZOE41)

Semester: IV Elective: 6 Credits: 2 Hours: 4

AQUACULTURE

1. Preparation of fish feed- Demonstration
2. Collection and preparation of pituitary extract (Hypophyzation, demonstration in a fish farm).
3. Morphometric measurements of fin fish and shell fish
4. Determination of fish age –Otolith method
5. Length weight relationship - (data analysis)
6. Population density assessment- capture and release method (Peterson's method).
7. Assessment of GSI and HSI in fishes
8. Visit to aqua farm / Industries

Spotters: Freshwater fishes - *Catlacatla, Labeorohita, Cirrhinusmrigala, Cyprinus carpio, Anguilla anguilla, Channa striatus,* Cat fishes: *Heteropneustesfossilis, Mystus* sp., *Chanoschanos*; Marine fishes –*Pampus argenteus, Scoliodon*; Shell fishes - *Lobster, Penaeus monodon, Perna viridis, Perna indica, Scylla serrata*, Fish parasites – *Gyrodactylus, Ichthyophthirius, Trichodina, Costia, Saprolegnia, Argulus*;
Predatory Aquatic insects: *Laccotrephes, Lethocerus, Diplonychus, Cybister; Aquatic weeds- Spirogyra, Nymphaea, Hydrilla, Eichhornia, Azolla*;
Fish diseases: Dropsy, Gill rot disease, Epizootic ulceratic diseases, Tail rot disease and Vibriosis; Techniques - Sewage fed fish farm, Composite fish culture, Induced Breeding, Integrated fish farming and Breeding Hapa

Ecology

1. Physicochemical analysis of fish culture pond water (Temperature, turbidity, pH, O2, alkalinity) - demonstration in a fish farm.
2. Morphometry of pond (Enclosed rectangular method (or) Shore length/ shore area and shore line development)
3. Measurement of primary productivity (dark and light bottle method)
4. Estimation of total dissolved solids and suspended solids
5. Estimation of nitrates and phosphates in water samples
6. Visit to ecosystem/ industries

Spotters: Ecology: Biogeochemical cycle (Oxygen, Phosphorous, Nitrogen and Carbon) Renewable (Biomass /energy, windmill, Tidal energy, Solar energy) and non renewable resources (Nuclear, fossil fuel etc.), Insitu and exsitu conservation, endangered animal list, diagram related to air, water, soil and noise pollution, Transparency-Secchi disc, Green house effect, Ozone layer, Global warming, Biomagnification and Biological indicators.

ECOLOGY

(Subject code: 23PZOS41)

Semester: IV Elective: 4 Credits: 3 Hours: 4

Objective: To create awareness about the environment in which animals live**.**

Course outcome: At the end of the course the students will be able to

1. Describe the biotic and abiotic components of environment.
2. Comprehend the structure of ecosystem.
3. Determine the role of environment on biodiversity.
4. Classify types and components of ecosystem.
5. Summarize community, population and biogeochemical cycles.
6. Develop appropriate environment conservation and management strategies.

Unit I: The environment and ecosystem (12 Hours)

The Environment - Atmosphere, Hydrosphere, Lithosphere, abiotic and biotic factors and its interaction; Ecosystem structure and function; Natural and Man-made ecosystem, energy flow, food chain and web;Ecological pyramids, primary productivity and its measurement.Animal associations-symbiosis, commensalism, mutualism, parasitism, predators and competition.

Unit II: Population and nutrient cycles (12 Hours)

Characteristics of a population - growth curves, density, natality, mortality, age distribution; Life study tables;Factors affecting population growth, regulation of population size; Biogeochemical cycles-Carbon, Oxygen, Nitrogen, Phosphate and Sulphur cycle;Interaction between nutrient cycles.

Unit III: Habitat and resources ecology (12 Hours)

Ecology of fresh water, marine, estuarine, terrestrial habitat, Renewable and non-renewable resources - animal resources.

Unit IV: Environmental conservation and management (12 Hours)

Principles of conservation, biodiversity management approaches, Wild life resources and protected areas, endangered and endemic animals in India;Conservation strategies (project tiger and biosphere reserve); Environmental stress and their management

Unit V: Pollution and management (12 Hours)

Environmental pollution and its biological effects; Air, water, soil and noise Pollution; Thermal radioactive and greenhouse effect; Ozone and global warming;Acid rain Biomagnifications; Biological indicators and their role in environmental monitoring and climate change.

Textbooks:

1. T. K. Saha. (2013). Ecology and Environmental biology, Books and Allied (P) Ltd. 628 pages.
2. Mohan P Arora. (2017). Ecology, Himalaya Publishing House. 554 pages.
3. P. D. Sharma. (2018). Fundamentals of Ecology. Rastogi Publications. 340 pages.

Reference books:

1. Eugene P. Odum. (2017). Fundamentals of Ecology. 5th edition. Cengage Learning. 624 pages.
2. G. Tyler Miller, Scott Spoolman. (2010). Environmental Science. 13th edition. Brooks / Cole Publishers. 452 pages.
3. R. Rajagopalan. (2023). Environmental Studies. 4th edition. Oxford University Press. 344 pages.
4. R. Rajagopalan. (2022). Environment and Ecology. 3rd edition. OakBridge Publishing. 598 pages.
5. Daniel. D. Chiras, (2014). Environmental Science. 10th edition. Jones and Bartlett Publishers. 708 pages.
6. D. Peter Stiling. (2002). Ecology: Theories and Applications, 4th edition. Prentice-Hall India Learning Pvt. Ltd. 1100 pages.
7. J. L. Chapman, M. J. Reiss. (2018). Ecology: Principles and Applications. 2nd edition. Cambridge University Press. 330 pages.
8. P. D. Sharma. (2017). Environmental Biology and Toxicology. 3rd edition. Rastogi Publications. 589 pages.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	M	L	L	L	L	L	M	S
CO2	L	M	L	M	L	M	M	S
CO3	M	S	L	L	L	M	L	L
CO4	M	S	M	S	M	M	L	L
CO5	M	M	L	M	M	L	L	L

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

ALLOTMENT OF MARKS

1. CIA – 1 conducted for 70 marks
2. CIA – 2 conducted for 70 marks
3. Average marks of CIA -1 and 2 will be converted to 70 marks
4. Assignment – 15 marks + *Viva voce* – 15 marks
5. Aggregate marks = 100

Question Pattern for CIA and Semester Examinations

Test Examination	Section A (1 mark)	Section B (2 marks)	Section C (5 marks)	Section D (15 marks)
	No choice	No choice	Either or	Open Choice
CIA test	10 x 1 = 10	5 x 2 = 10	4 x 5 = 20	2 x 15 = 30
Semester examinations	20 x 1 = 20	5 x 2 = 10	5 x 5 = 25	3 x 15 = 45

Question Pattern and Marks for Practical Examination

Type of questions	Marks
Major Practical Procedure-5 Marks Performance of the experiment, observation, calculation and table or graph-7 Marks and Discussion -3Marks	15
Minor Practical / Instrumentation Performance of the experiment/observation, calculation and table or graph-7 Marks and Discussion -3 Marks	10
Identification of animals / instruments / spotters (5 or 10 with 1 mark or 0.5 mark each) / Mini project / Insect Box	5
Spotters (5 x 3) -Identification – ½ mark, Diagram – ½ mark, Labelling – ½ mar (Unlabelled diagram carries no mark)and explanation - 1½ mark	15
Record note book	5
Total	50

INTELLECTUAL PROPERTY RIGHTS

(Subject Code: 23PZOVA11)

Add on Course: 1 Credits: 3 Hours: 30

Course Objectives: To make aware of the importance of analysis of quantitative and qualitative information from biological studies.

Course Outcomes: Upon completion of this course, students would be able to

1. Identify the Claim the rights for the protection of the invention done in their project work**(K1)**
2. Understand the criteria to fit one's own intellectual work in particular form of IPR**(K2)**
3. Register in our country and foreign countries of their invention, designs and theory written by students during their project**(K3)**
4. Analyze the various aspects of International treaties and Conventions**(K4)**
5. Evaluate the enforcement measures of Intelligent Property rights **(K5)**

Unit I: Introduction to IPRs (6 Hours)

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 (6 Hours)

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 (6 Hours)

TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

Unit IV: Digital Innovations and Developments (6 Hours)

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 (6 Hours)

Enforcement Measures, Emerging issues - Case Studies.

Text Books:

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

References:

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**
CO1	M	S	L	L	S	S	M	S
CO2	M	S	S	S	M	S	M	L
CO3	M	S	S	S	S	S	S	S
CO4	M	S	S	S	S	M	L	L
CO5	S	S	S	S	M	M	S	L
CO6	S	S	S	M	S	M	S	S

DAIRY FARMING

(Subject Code: 23PZOVA12)

Value Added Course 1: Credits: 3 Hours: 30

Course Objectives: To make aware of the economic and cultural importance of Dairy farming

Course Outcomes: Upon completion of this course, students would be able to

1. Identify the various practices in Dairy farming. To know the needs for Dairy farming and the status of India in the global market.**(K1)**
2. Understand the Different Managemental Parameters **(K2)**
3. Apply the techniques and practices needed for Dairy farming **(K3)**
4. Analyze the basic principles of nutrition, kinds of feeds and their role on growth and reproduction **(K4)**
5. Evaluate dairy farm diseases, and preventive and control measures. **(K5)**
6. Know the difficulties in Dairy farming and be able to propose plans against it..**(K6)**

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

Unit I : Introduction (6 Hours)

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 : Dairy Farming (6 Hours)

Construction of Model Dairy House - Types of Housing - Different Managemental Parameters - Winter Management - Summer Management.

Unit III :Nutrition and feeding (6 Hours)

Feedstuffs available for livestock- Roughages -Concentrates - Energy rich concentrates - Protein rich concentrates - Mineral Supplements - Vitamin Supplements - Feed additives - Feeding management - Calves Feeding - Feeding of adults - Feeding of pregnant dairy animals - Feeding pregnant heifer.

Unit IV :Dairy farm Management (6 Hours)

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 : Dairy farm Diseases (6 Hours)

Contagious disease - Common Bacterial - Protozoal - Helminth and Viral Diseases - Parasitic Infestation - Vaccination - Biosecurity.

Text Books:

1. The Veterinary Books for Dairy Farmers by Roger W. Blowey.
2. Hand Book of Dairy Farming by Board Eiri.
3. Handbook of animal husbandry TATA, S.N ed., ICAR 1990
4. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai.
5. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea & Fabiger Publisher.

Reference Books:

1. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.
2. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, NewYork.

Mapping with programme outcomes								
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	M	S	L	L	S	S	M	S
CO2	M	S	S	S	M	S	M	L
CO3	M	S	S	S	S	S	S	S
CO4	M	S	S	S	S	M	L	L
CO5	S	S	S	S	M	M	S	L
CO6	S	S	S	M	S	M	S	S

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

Extra Credit Courses (ECC)

BIODIVERSITY

(Subject code: 23PZOEC1)

Semester: I **Credits: 3** **Hours: 30**

Course in-charge: Dr. P. Selvaraj and Dr. A. Jeyaseeli

Course objective: To understand the basic classification, concepts of biodiversity and organization of related animals.

Course outcomes: At the end of the course the students will be able to

1. Describe principles of taxonomy.
2. Comprehend the salient features of invertebrates.
3. Demonstrate the general characters of chordates.
4. Classify animals.
5. Summarize adaptive features of highlighted animals.
6. Integrate adaptation with the survival of animals.

Unit I: Principles and Methods of Taxonomy (6 Hours)

Concepts of species and hierarchial taxa, biological nomenclatures, classical (Wittekers, five Kingdom concept) and quantitative methods of taxonomy of animals. Levels of structural organization, Zoogeographic zones.

Unit II: Protozoa- Nematodes (6 Hours)

General characters - Classification up to classes, salient features and examples of protozoa, porifera coelenterate, ctenophore and helminthes. Type study – *Paramecium caudatum, obeliageniculata, Taeniasolium, Plurobrachia*; General topic - Affinities of Ctenophora, parasitic diseases, parasitic adaptations and life cycle.

Unit III: Annelid- Echinodermata (6 Hours)

General characters - Classification up to classes, salient features and examples of Annelida, Arthropoda Mollusca and echinoderamata. Type study- *Megascolexmauritti*and *Periplanetaamericana, Pilaglobosa* and *Asteriasrubens.* General topic: Larval forms, Affinities of Peripatus.

Unit IV:Prochordates, Pisces and Amphibian (6 Hours)

General characters - Classification up to classes, salient features and examples of Prochordates, Pisces and Amphibians. Type study- Amphioxus, balanoglossus, ascidia, Holocephali, dipnoi and *Rana*. General topic, metamorphosis in ascidia, migration in fishes, parental care in amphibian.

Unit V: Reptiles, Aves and Mammals (6 Hours)

General characters - Classification up to orders, salient features with examples. Type study- C*olumba livia*, Rabbit; Poisonous and non poisonous snakes, mechanism of biting and first aid. Flight adaptation in birds, Adaptations of aquatic mammals.

Textbooks:

1. Kohli, K.S. and KavitaSahni 2010. Animal Diversity and Evolution, Ramesh Book Depot, 65 Shivaji Nagar, Civil Lines, Jaipur.
2. Jordan, E.L. and Verma P.L. 2003. Invertebrate Zoology, S. Chand & Company Ltd.,Ramnagar, New Delhi.

Reference books:

1. Jan A. Pechenik, 2002. Biology of Invertebrates, 4th edition, TATA McGraw-Hill Edition.
2. Kenneth V. kardong, 2005. Vertebrates, 4th edition, TATA McGraw-Hill Edition.
3. D.T. Anderson, 2001, Invertebrate Zoology. 2nd edition, Oxford university press.
4. Singh, B.K. 2004. Biodiversity conservation and management, Mandal Deep Publications, Jaipur.
5. EkambaranathaAyyar 1993. Outlines of Zoology, Vol. I., S. Viswanathan (Printers & Publishers) Pvt. Ltd. Chennai.
6. Kumar and Asija 2000 - Biodiversity, Principles and conservation, Agrobiol (India), Jodhpur.

MEDICAL ENTOMOLOGY

(Subject code: 23PZOEC2)

Semester: II Credits: 3 Hours: 30

Course in-charge: Dr. T. Pushpanathan and Dr. T. Elizabeth

Course objective: To gain knowledge on insect borne diseases and control strategies

Course outcomes: At the end of the course the students will be able to

1. Describe biology and impacts of various species of mosquitoes.
2. Comprehend the role of flies as a vector.
3. Demonstrate the biology of bugs, lice and cockroach in human health
4. Classify diseases of non-insects likes ticks and mites
5. Summarize the economic importance of disease causing insects.
6. Integrate physical, chemical and biological methods in vector management.

Unit I : Mosquitoes

Distribution, Salient features, Morphology, Biology of medically important vector species Anopheles (*An. stephensi*), Aedes (*Ae. aegypti*), Culex (*Cx. Quinquefasciatus*), Mansonia (*Ma. annulifera*), *Culex* and *Aedes* mosquitoes; Mosquito borne diseases - Malaria, Filariasis, Dengue, Elephantiasis and Chikungunya.

Unit II : Flies and Public Health

Biology, disease transmission and control methods of Black flies (Simuliidae), Horse flies*(Tabanus)*, Tsetse flies *(Glossina)* and House flies (*Musca*)

Unit III : Bugs, Lice and Cockroach

Salient features, biology, disease transmission, prevention and control measures of Bed bugs, Triatomine bugs, Head and Body louse and Cockroach (Give biological names)

Unit IV : Ticks and Mites

Salient features, biology, disease transmission and management of ticks (soft and hard ticks) and mites.

Unit V : Vectors Control Methods

Physical, Chemical and biological methods; Commercial products; National and international Eradication Programmes of Vector control.

Textbooks:

1. Service. M. 2002. Medical Entomology for students,Cambridge University Press.
2. Tyagi B.K. 2003. Medical Entomology, Scientific Publishers, Jodhpur.

Reference books:

1. Rathinasamy G.K. 1974. A Handbook of Medical Entomology and ElementryParastitology, S.Viswanathan Printers and Publication Pvt., Ltd., Chennai.
2. Parthiban, M. and B. Vasantharaj David. 2007. Manual of Household and Public Health pests and their control, Namrutha Publications, Chennai.

ANIMAL BEHAVIOUR

(Subject code: 23PZOEC3)

Semester: III Credits: 3 Hours: 30

Course in-charge: Dr. J. Ronald and Dr. S. Mabel Parimala

Course objective: To understand the basic concepts of animal social and reproductive behaviours and their function-related environment.

Course outcomes: At the end of the course the students will be able to

1. Describe the general and innate behavior of animals.
2. Understand the ecological aspect of behaviours
3. Relate the habituation of animal learning to the circadian rhythms
4. Analyze social behavior of fishes, birds and mammals
5. Summarize reproductive behaviors in animals
6. Predict the behavior of animals.

Unit I: General and innate behaviour

Definitions of ethology and animal psychology - ethogram; classification of behavioural patterns - neural and hormonal control of behaviour - communication - genetic and environmental components in the development of behaviour.

Unit II: Ecological aspects of behaviour

Habitat and food selection -optimal foraging theories- aggression - homing - territoriality - dispersal- host-parasite relationship

Unit III: Biological rhythms, learning and memory

Circadian and circannual migration of fishes and birds; conditioning, habituation - insight learning - association learning - reasoning - cognitive skills

Unit IV: Social behaviour

Aggregation, Schooling in fishes, Flocking in birds, Herding in mammals; Social living in bees, ants and primates

Unit V: Reproductive behaviour

Reproductive strategies - mating systems - mate choice - sex differences - courtship - sexual selection - parental care in invertebrates and vertebrates

Textbooks / Reference books:

1. McFarland 1985. Animal behaviour, ECBS Longman, Essex.
2. Manning and DawkinsM. S. 1998. An Introduction to Animal Behaviour, Cambridge University Press, Foundation Books, New Delhi.
3. Alcock, J. 2006. Animal Behaviour, Sinauer Associates, INC, Sunderland, Massachusetts.

BIOPESTICIDES

(Subject code: 23PZOEC4)

Semester: IV Credits: 3 Hours: 30

Course in-charge: Dr. J. Babila Jasmine and Dr. R. Santhakumari

Course objective: Students should know about the consequences of using pesticides and the appropriate remedy in this regard.

Course outcomes: At the end of the course the students will be able to

1. Describe pesticides that prove injurious to fauna and flora.
2. Understand various eco-friendly potions of microbes.
3. Illustrate economically important pests.
4. Classify different botanicals and their role in pest control.
5. Summarize predators and parasites in pest control.
6. Integrate semio-chemicals in pestiferous insects control

Unit I: Pesticide vs Biopesticides

Pesticides /Insecticides – problems (insecticide resistance, insecticide residues, associated with plants, human beings, domestic animals and wield animas); Biopesticides- definitions, advantages and limitations, types /categories

Unit II: Microbial insecticides

Special characters of bacteria, fungi and virus which possess insecticidal activity; Bacteria – *Bacillus thuringiensis*; Fungi – Metarhizium and Beauveria; Viruses – Baculoviruse, NPV

Unit III: Botanical insecticides

Advantages and disadvantages; common plants with insecticidal value (neem, annona, pungamia, pyrethrins); commercial botanicals and their utility in pest management

Unit IV: Natural enemies

Predators and Parasitioids – definition, salient features, types, differences between predators and parasitoids, examples (Ladybird beetles, lacewings, Trichogramma, tachnides), benefits and drawbacks

Unit V: Semiochemicals

Allelochemicals (interspecific) – kairomones, allomones and synomoes pest control value (short account only); Pheromones –types, Biocontrol role and pheromone traps.

Textbooks / Reference books:

1. V. Nandagopal et al. 2008. Pheromones : principles and practices, AZRA, Cuttack.
2. B. Vasantharaj David and V.V. Ramamurthy. 2011. Elements of economic entomology. NP Namrutha Publication, Chennai.
3. J. Francis Borgio, K. Sahayaraj and I. AlperSusurluk. 2011. Microbial insecticides: principles and application, Nova Science Publisher, Inc., New York.
4. K. Sahayaraj. 2007. Indian insect predators in biological control,Daya Publishing House, New Delhi.