ST. MARY'S COLLEGE (AUTONOMOUS)

(Re-accredited with A+ Grade by NAAC)

Thoothukudi – 628001, Tamil Nadu

(Affiliated to Manonmaniam Sundaranar University)

Syllabus

M.Sc. Zoology

School of Biological Sciences

Outcome Based Curriculum

(w.e.f. 2024)

Preamble

Master of Science in Zoology is a post graduation course of St. Mary's College. The students pursuing this course would have to develop in-depth understanding of various aspects. The working principles, design, guidelines and experimental skills associated with different fields of Zoology. In pace with the recent trends and developments in Zoology the course content is being modified. There is also scope for self- employment. The practicals will improve all skills of students in microscopy and different laboratory techniques. This curriculum of the zoologists, for the zoologists and by the zoologists developed with the united efforts will take our ever progressive subject to greater heights in the years to come.

Vision: To prepare young women face the challenges of life through education, an ideal weapon for empowerment.

Mission: To impart knowledge and skills in zoology through specialization in recently emerging technologies and thereby to produce quality graduates capable of contributing to the development of knowledge based society.

Programme Outcome:

PO. No.	**After completion of the Postgraduate programme the students of St. Mary's College will be able to**
PO-1	acquire expertise knowledge in their respective disciplines and become professionals.
PO-2	develop critical/logical thinking skills, managerial skills and become locally, nationally & globally competent and be a lifelong learner
PO-3	pursue research / higher learning programme & apply their experiment and research skills to analyse and solve complex problems.
PO-4	compete in the job market by applying the knowledge acquired in Arts, Science, Economics, Commerce and Management studies
PO-5	be an empowered and economically independent woman with efficient leadership qualities and develop the themselves as a holistic person

Programme Specific Outcome:

PO. No.	**After completion of the M.Sc Zoology Degree programme, the postgraduates will be able to**
PSO-1	acquire comprehensive knowledge in classical and modern zoology, mastering core principles, constructs, emerging techniques and methodologies to become adept professionals in the field
PSO-2	exhibit skills and competencies to cater the academic, entrepreneurial and industrial needs, engaging in lifelong learning practices to adapt to evolving biological paradigms
PSO-3	pursue higher learning opportunities, refining their observational, experimental, analytical, critical thinking and problem solving skills to dissect complex biological problems and contribute to innovative solutions in research
PSO-4	apply their acquired knowledge of zoology across various broad spectrum of domains, encompassing conservation, environmental sciences, biotechnology, and related interdisciplinary fields
PSO-5	develop leadership qualities while striving for holistic personal growth, build foundation for economic empowerment, contributing to a more inclusive and diverse scientific progress to society

ST. MARY'S COLLEGE (AUTONOMOUS), THOOTHUKUDI

PG Zoology

Course Structure (w. e. f. 2024) Semester – I

Components	Course Code	Course Title	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core I	24PZOC11	Biochemistry	6	5	40	60	100
Core II	24PZOC12	Structure and Function of Invertebrates	5	4	40	60	100
Core III	24PZOC13	Comparative Anatomy of Vertebrates	5	4	40	60	100
Core Practical I	24PZOCR1	Biochemistry	2	1	40	60	100
Core Practical II	24PZOCR2	Structure and Function of Invertebrates , Comparative Anatomy of Vertebrates	4	2	40	60	100
Elective I (Generic Discipline Centric)	24PZOE11/ 24PZO E12	**Economic Entomology/** Sericulture	4	3	40	60	100
Skill Enhancement Course I	24PZOSE1	Poultry Farming	4	3	40	60	100
Total			**30**	**22**			

Semester – II

Components	Course Code	Course Title	Contact Hours / Week	Credits	Max .Marks		
					CIA	ESE	Total
Core IV	24PZOC21	Animal Physiology	6	5	40	60	100
Core V	24PZOC22	Cell and Molecular Biology	5	4	40	60	100
Core VI	24PZOC23	Genetics and Evolution	5	4	40	60	100
Core Practical III	24PZOCR3	Animal Physiology	2	1	40	60	100
Core Practical IV	24PZOCR4	Cell and Molecular Biology, Genetics and Evolution	4	2	40	60	100
Elective II (Generic Discipline Centric)	24PZOE21 24PZOE22	**Research Methodology/** Nanotechnology	4	3	40	60	100
Skill Enhancement Course II	24PZOSE2	Aquaculture	4	3	40	60	100
MOOC (Compulsory)				+2			
		Total	**30**	**22+2**			

Semester – III

Components	Course Code	Course Title	Contact Hours / Week	Credits	Max .Marks		
					CIA	ESE	Total
Core VII	24PZOC31	Computational Biology	6	5	40	60	100
Core VIII	24PZOC32	Immunology	5	5	40	60	100
Core IX	24PZOC33	Microbiology	5	4	40	60	100
Core Practical V	24PZOCR5	Computational Biology	2	1	40	60	100
Core Practical VI	24PZOCR6	Immunology, Microbiology	4	2	40	60	100
Elective III (Generic Discipline Centric)	24PZOE31 24PZOE32	**Applied Biotechnology/** Population Biology and Ethology	4	3	40	60	100
Skill Enhancement Course III	24PZOSE3	Dairy Farming	4	3	40	60	100
Internship / Self Study (Optional)	24PZOI31 24PZOSS1	 Zoology for Competitive Examination		+2			
		Total	**30**	**23+2**			

Semester – IV

Components	Course Code	Course Title	Contact Hours / Week	Credits	Max. Marks		
					CIA	ESE	Total
Core X	24PZOC41	Marine Biotechnology	6	5	40	60	100
Core XI	24PZOC42	Developmental Zoology	6	5	40	60	100
Core XII	24PZOC43	Conservation Biology	6	5	40	60	100
Core Practical VII	24PZOCR7	Marine Biotechnology	2	1	40	60	100
Core Practical VIII	24PZOCR8	Developmental Zoology, Conservation Biology	4	2	40	60	100
Core XIII (Project)	24PZOP41	Project and Viva Voce	6	5	40	60	100
Total			**30**	**23**			

Note: 1. It is mandatory for all I PG students to attend the course through Swayam Portal. Students who pass in MOOC through portals will get extra credit. Students who fail in MOOC can appear for supplementary exam and the institution will provide the certificate. No extra credits will be given.

2. Internship can be completed during the II Semester vacation.

SEMESTER I			
Core I : Biochemistry			
Course code: 24PZOC11	**Hrs/Week: 6**	**Hrs/Sem: 90**	**Credits: 5**

Objectives

- To develop and enhance an optimum academic environment to prepare professional graduates in the field of biochemistry
- To give a broad based knowledge on the physical and chemical properties of molecules, and their status of occurrence in biological system to maintain homeostasis

Course Outcome

CO.No	Upon completion of this course, students will be able to	CL
CO- 1	describe the structure and functions and properties of biomolecules	K1
CO-2	compare the specificity of enzymes (biochemical catalysts) and the chemistry involved in enzyme action.	K2
CO-3	apply the insights of biomolecules and biological buffers in real life situations, research and industry	K3
CO-4	examine the metabolic pathways of protein, amino acids, carbohydrates, fats and nuceic acids	K4
CO-5	evaluate the concepts of biochemistry to manage metabolic error health issues and handle biochemical problems	K5

Unit I Atoms and Molecules (18 Hrs)

Structure of an atom, chemical bonds (ionic, covalent and hydrogen). Structure and properties of water. Vanderwaals interaction, role of water in life. pH and buffers-weak acids and alkalies, Henderson and Hasselbalch's equation - Biological buffer system

Unit II Carbohydrates (18 Hrs)

Classification – structure – properties and functions of carbohydrates, Metabolism: glycolysis – TCA cycle – energy budget of glucose oxidation-– glycogenolysis – glycogenesis – gluconeogenesis, Disorders of carbohydrate metabolism - Diabetes Mellitus and Cori's disease.

Unit III Proteins (18 Hrs)

Classification – properties, functions and structural configuration of proteins – metabolism of proteins – metabolism of tryptophan – phenylalanine and tyrosine - Inborn errors of metabolism - Phenylketonuria and Hartnup's disease. Ramachandran plot

Unit IV Lipids (18 Hrs)

Classification – structure - Biological importance of simple lipids (Triglycerides and wax), compound lipids (phospholipids and glycolipids) and derived lipids (saturated, unsaturated fatty acids and cholesterol) – β oxidation, ketogenesis – biosynthesis of fatty acids, disorders of fat metabolism - Hypercholesterolemia, Hyperlipoproteinemia and Atherosclerosis. Role of liver in fat metabolism.

Unit V Enzymes and Nucleic acids (18 Hrs)

Nomenclature – classification – properties – functions and mechanism of enzyme action and its regulation – Michaelis - Menten equation – coenzyme, isoenzyme. Nucleic acids - chemistry of nucleic acids, structure, biosynthesis and degradation, purine and pyrimidine nucleotides, disorders of their metabolism -Gout, Severe combined immunodeficiency, Orotaciduria and Thymidine phosphorylase deficiency.

Books for Reference

1. Ambika Shanmugam, *Fundamentals of Biochemistry for Medical Student*s, Navabharat Printers and Traders, Madras, 2012.
2. Pankaj Naik, *Biochemistry for Medical Students* 4thedition, Health Science Publishers, NewDelhi, 2018.
3. Jain.J.L, Sunjay Jain, Nitin Jain, *Fundamentals of Biochemistry*, S.Chand & Company, New Delhi, 2007.
4. Styer.L.W.H., *Biochemistry*, Freeman & Company, San Francisco, 1995

5. Murray.R.K. Gaaner.D.K, Mayer.P.A and Rodwell.V.W. *Harper's Biochemistry*, 24th edition. Prentice Hall of Japan, Inc, Tokyo, 1996.
6. Rastogi.S.C. *Biochemistry*, Second edition. Tata McGraw Hill Publishing Company Ltd., New Delhi, 2003.
7. Satyanarayana.U and U.Chakrapani, *Biochemistry*, Fourth edition. Elsevier & Allied. Haryana and Kolkata, 2014.
8. Edward Staunton West, Wilbert.R. Todd. Howard S.Mason, John .T.Van. Bruggen, *Biochemistry*, Fourth edition. Oxford and IBH Publishing Co. New Delhi, 1966.
9. Bernard L. Oser, *Hawk's Physiological Chemistry*, 14th edition.Tata McGraw Hill Publishing Company Ltd. New Delhi, 1965.
10. Chatterjee.M.N, *A Textbook of Biochemistry*. Jaypee Brothers, Medical Publishers Pvt Ltd. New Delhi, 2010.
11. Lehninger, A. *Principles of Biochemistry*, CBS Publishers & Distributers, New Delhi, 2005.

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	2	2	3	3	3	3	3	2
CO-2	3	3	2	2	3	3	2	2	3	2
CO-3	3	3	3	3	3	3	3	3	3	3
CO-4	3	2	3	2	2	3	3	3	2	3
CO-5	3	3	3	3	3	3	3	3	3	3
Ave.	3	2.8	2.6	2.4	2.8	3	2.8	2.8	2.8	2.6

Mapping	**<40%**	**≥ 40% and < 70%**	**≥ 70%**
Relation	**Low Level**	**Medium Level**	**High Level**
Scale	**1**	**2**	**3**

PRACTICALS

Hrs/Week: 2 **Course code: 24PZOCR1** **Credit: 1**

1. Effect of pH on salivary amylase activity.
2. Effect of substrate concentration on salivary amylase activity.
3. Salivary amylase activity in relation to enzyme concentration.
4. Quantitative estimation of carbohydrate
5. Quantitative estimation of muscle protein
6. Determination of iodine number of an edible oil
7. Separation of lipids by TLC -Demonstration only
8. Separation of amino acids by paper chromatography / Ninhydrin method
9. Preparation of buffers : acetic acid and acetate buffers
10. Phenylketonuria (chart)

Books for Reference

1. Jayaraman, J, *Laboratory Manual in Biochemistry*- New age International (P) Ltd. Publishers, New Delhi, 2000.
2. Kanai.L, Mukherjee & Swarajit Ghosh, *Medical Laboratory Technology* – 2nd Edition, Tata McGraw Hill Education (P) Ltd- New Delhi, 2012.
3. DeeptiSaini and Deepak K. Sain, *Hand Book of Practical Biochemistry* – PEE PEE Publishers & Distributers (P) Ltd., New Delhi, 2008.

SEMESTER I			
Core II: Structure and Function of Invertebrates			
Course Code: 24PZOC12	**Hrs/Week:5**	**Hrs/Sem:75**	**Credits:4**

Objectives:

- To understand the basic concepts of lower animals and observe the structure and functions.
- To examine the systemic and functional morphology of various group of invertebrates.

Course Outcome

Co.No	Upon completion of this course, students will be able to	CL
CO-1	describe the different levels of biological diversity through identification and systematic classification to become expertise in their respective discipline	K1
CO-2	discuss the structural and functional organization of invertebrates to understand the interactions among living organisms	K2
CO-3	compile the anatomy and developmental process of invertebrates to gain knowledge and skill in the fundamentals of animal science	K3
CO-4	analyse complex interactions among animals, their distribution and relationship with the environment to find solution in research	K4
CO-5	evaluate the complex evolutionary process, adaptations in relation to environment	K5

Unit I **Nomenclature** **(15Hrs)**

Structure and function in invertebrates, Principles of Animal taxonomy, Species concept, International code of zoological nomenclature, Taxonomic procedures, New trends in taxonomy.

Unit II **Coelom and Locomotion** **(15Hrs)**

Organization ofcoelom- Acoelomates, Pseudocoelomates, Coelomates, Protostomia andDeuterostomia,Locomotion-Flagella and ciliary movement inProtozoa, Hydrostatic movement in Coelenterata, Annelida and Echinodermata.

Unit III **Digestion and Respiration** **(15Hrs)**

Nutrition andDigestion- Patterns of feeding and digestion in lower metazoan, Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration- Gills, lungs and trachea, Respiratory pigments; Mechanism of respiration.

Unit IV **Excretion and Nervous system** **(15Hrs)**

Excretion - Organs of excretion - coelom,coelomoducts, Nephridia and Malphigian tubules, Mechanisms of excretion, Excretion and osmoregulation. Nervous system- Primitive nervous system- Coelenterata and Echinodermata, Advanced nervous system- Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda).

Unit V **Invertebrate Larvae and Evolutionary significance** **(15Hrs)**

Invertebrate larvae-Larval forms of free living invertebrates -Phylum - Porifera, Coelenterata , Arthropoda, Mollusca,and Echinodermata, Larval forms of parasites- Helminthes,Strategies and evolutionary significance of larval forms.

Books for Reference

1. Dechenik, J. A. *Biology of Invertebrates* (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.2015
2. Barnes, R. S. K. P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. *The Invertebrates: A Synthesis.* Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi.2013
3. Kotpal .L. *Modern Text book of Zoology* Invertebrates (12th Edition -1 R Rastogi Publishers 2020
4. Barnes,R.D.*Invertebrate Zoology*, (Second Edition), Holt-Saunders International Edition, pp-1024.1974.
5. Jordan E.C. and Verma P.S. *InvertebratesZoology* revised edition S. Chand and Company Ltd New Delhi 2009
6. Ekambaranatha Ayyer M.A.Viswanathan.S. *Manual of Zoology,*Vol 1ViswanathanPrinters and Publishers Chennai.1993
7. Ekambaranatha Ayyer M.A.Viswanathan.S. *Manual of Zoology,*Vol I1ViswanathanPrinters and Publishers Chennai.1983
8. Barrington, E. J.W. *Invertebrate Structure and Function.* The English Language Book Society and Nelson, pp-765.1979

Web Resources

1. https://www.nationalgeographic.com/animals/invertebrates/
2. https://bit.ly/3kABzKa
3. https://www.nio.org/
4. https://greatbarrierreef.org/

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	2	2	3	2	2	3	2
CO-2	3	1	2	2	1	3	2	3	3	2
CO-3	3	3	2	2	2	3	3	2	2	2
CO-4	3	3	3	3	3	2	2	3	3	2
CO-5	3	3	2	2	3	2	2	2	3	3
Ave.	3	2.6	2.4	2.2	2.5	2.3	2.2	2.4	2.8	2.2

Mapping	**<40%**	**≥ 40% and < 70%**	**≥ 70%**
Relation	**Low Level**	**Medium Level**	**High Level**
Scale	**1**	**2**	**3**

PRACTICALS

Hrs/Week:2 **Course Code: 24PZOCR2** **Credits:1**

INVERTEBRATES

Dissection

Cockroach : Nervous system, Reproductive system
Prawn : Appendages, nervous system and digestive systems

Mounting

Earthworm : Body setae
Cockroach : Mouth parts

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

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

Spotters

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

Books for Reference

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

2. Sinha, J., A. K. Chatterjeee, P. Chattopadhya. . *Advanced Practical Zoology*, Arunabha Sen Publishers, pp-1070.2011

SEMESTER I			
Core III : Comparative Anatomy of Vertebrates			
Course Code: 24PZOC13	**Hrs/Week: 5**	**Hrs/Sem:75**	**Credits: 4**

Objectives

- To understand the anatomical features in a broad range of vertebrates.
- To explore the evolutionary relationships among vertebrates.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	C L
CO-1	identify anatomical traits, functions and evolutionary relationships across diverse vertebrates for achieving success in professional studies in this field	K1
CO-2	discuss societal needs through their understanding of vertebrate structures and functions, thereby contributing to the job market and broader scientific progress	K2
CO-3	apply scientific knowledge in comparative anatomy, both theoretical and experimental, at the upper division level.	K3
CO-4	compare and contrast the external anatomy, skeletal features, and internal organ systems of the different groups of vertebrates	K4
CO-5	evaluate the study of comparative vertebrate anatomy and its impact on human society directly and indirectly	K5

Unit I **Origin of Vertebrates** **(15 Hrs)**

Protochordata – general characters of Hemichordata, Urochordata and Cephalochordata. Origin of vertebrates- Chordates verses Vertebrates- Ancestry of vertebrates- Theories of invertebrates ancestry of chordates Advanced characters of vertebrata over Protochordata- Evolutionary history of vertebrates.

Unit II **Diversity of Vertebrates and Integumentary System** **(15 Hrs)**

General characters of vertebrates. Diversity of vertebrates- numerical strength, kinds- categories. Vertebrate integument and its derivatives. Development,

general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.

Unit III Circulatory System and Respiratory System (15 Hrs)

General plan of circulation in various groups; Blood; Evolution of heart; Evolution of aortic arches and portal systems. Respiratory system: Internal and external respiration; Comparative account of respiratory organs.

Unit IV Skeletal System and Urinogenital System (15 Hrs)

Skeletal System - Comparative account of jaw suspensorium- Limbs of Amphibians, Reptiles - Limbs and Girdles of Aves and Mammals;

Urinogenital System - Evolution of vertebrate kidney-Archnephros, Pronephros, Mesonephros, Metanephros- Comparative study of Urinogenital organs in vertebrates-Elasmobranchs, Amphibia, Reptilia, Aves and Mammals

Unit V Sense Organs and Nervous System (15 Hrs)

Sense organs- classification of receptors. Organs of olfaction and taste- Lateral line system- Electroreception. Nervous system- Comparative anatomy of the brain in relation to its functions; Nerves-Cranial, Peripheral and Autonomous nervous systems.

Books for Reference

1. Yong, J. Z. *The Life of Vertebrates*, English Language Book society, London, pp-645. 1981
2. Romer, A.S. and W.B.S. Saunders. *The Vertebrate Body*, Philadelphia, pp-600. 1971
3. Waterman, A.J. *Chordate Structure and Function*, MacMillan Co., New York, pp.587. 1972
4. Parker T. J. and W. A. Haswell. *A Text Book of Zoology*, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750. 1962
5. Ekambaranatha Ayyar and T. N. Ananthakrishnan. *Manual of Zoology*, Vol – II, S. Viswanathan Pvt. Ltd. Chennai. 2009.
6. Kotpal, R.L. *Modern Text Book of Zoology Vertebrates*, 4th Edition, Rastogi Publications, Meerut, pp-968. 2019

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	2	1	3	2	3	3	3	3	1
CO-2	3	3	3	3	2	3	3	3	3	3
CO-3	3	3	3	3	3	3	3	3	2	2
CO-4	3	2	2	3	3	3	2	3	2	2
CO-5	3	3	2	3	3	3	2	3	3	3
Ave.	3.0	2.6	2.2	3.0	2.6	3.0	2.8	3.0	2.6	2.2

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

PRACTICALS

Hrs/Week: 2 **Course code: 24PZOCR2** **Credit: 1**

I. Mounting of Cycloid, Ctenoid and Placoid scales

II. Dissection: Nervous system of *Scoliodon* (Demonstration)

1. Nervous system of *Scoliodon* – 5^{th} or Trigeminal nerve
2. Nervous system of *Scoliodon* – 7^{th} or Facial nerve
3. Nervous system of *Scoliodon* – 9^{th} and 10^{th} or Glossopharyngeal & Vagus nerve

III. Skeletal system of frog

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

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

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

Books for Reference

1. Lal, S.S. *Practical Zoology*, Rastogi Publications, pp-484. 2009.
2. Iuliis G. D. and D. Pulerà, *The Dissection of Vertebrates: A Laboratory Manual.* Academic Press, Imprint of Elsevier Publication, pp-416. 2007.

3. Verma, P.S. *Manual of Practical Zoology: Chordates*, S. Chand Publishing Company, pp-528. 2000
4. Preeti, G. and C. Mridula, *Modern Experimental Zoology*, Indus International Publication. 2000.
5. Sinha, J., A. K. Chatterjeee and P. Chattopadhya. *Advanced Practical Zoology*, Arunabha Sen Publishers, pp-1070. 2011.

SEMESTER - I			
Elective I: Economic Entomology			
Course Code: 24PZOE11	**Hrs / week: 4**	**Hrs / Sem: 60**	**Credits: 3**

Objectives:

- To impart knowledge on identification, life history and ecology of insect pests and predators/ parasites and the basic principles and strategies for their management
- To understand the role of insects in human health and household

Course Outcome

CO. No	Upon completion of this course, students will be able to	CL
CO-1	recall the taxonomic categorization of insects and define their role in human life	K1
CO-2	interpret standard protocols for rearing beneficial insects and management of destructive insect pests and vectors	K2
CO-3	apply and judge the scientific method in conducting inquiry-based research in the field of entomology	K3
CO-4	analyze potential impact of different insect species on agriculture, human health, and environment in general; to be knowledgeable about potential control strategies with environmental consciousness	K4
CO-5	recommend an appropriate field of entomology to establish and entrepreneurial venture	K5

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

Insects and their biological success - Basic concepts in Insect Taxonomy and classification. Imm's classification down to orders with their diagnostic characters of any ten significant orders – Thysanura, Odonata, Orthoptera, Phasmida, Mallophaga, Hemiptera, Coleoptera, Diptera, Lepidoptera, Hymenoptera - methods of collection, killing and preservation of insects.

Unit II **Beneficial insects:** **(12 Hrs)**

Chemical composition and uses of products of beneficial insects: Silkworms – types, silk, by-products of silkworm; Honey bees - types, Bee Products - honey, beeswax, venom, bee pollen, propolis and royal jelly; Lac insects - types, economic importance of lac, Pollinators, predators, insects as human food, scavengers, weed killers, soil-builders.

Unit III **Destructive insects:** **(12 Hrs)**

Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Bionomics and control measures any one insect pests of paddy (*Scirpophaga incertulas*), cotton (*Helicoverpa armigera*), sugarcane (*Chilo sacchariphagus indicus)* vegetables (Brinjal - *Leucinodes orbonalis*), coconut (*Oryctes rhinoceros***)** and stored grains cereals – internal (*Sitophilus oryzae***)** and external feeders (*Tribolium castaneum*)

Unit IV **Pest management/Control strategies:** **(12 Hrs)**

Methods and principles of pest control - Natural, cultural, mechanical, legal, biological, chemical, Autocidal - Merits and demerits of these methods in pest control - Integrated Pest Management - Concepts and practice.

Unit V **Insects in Relation to Public Health and House hold** **(12 Hrs)**

Insects in relation to public health – Annoyance, dermatosis, myiasis, envenomization, allergic reaction and entomophobia. Human Head Louse Vector biology - life cycle and control measures – Mosquitoes (Anopheles and Aedes), Housefly, Vector borne disease: Dengue, Malaria, Filariasis.

Book for Reference:

1. Ayyar, L.V. R. *Hand book of Economic Entomology for South India*. Narendra Publishing House. New Delhi, 1936.
2. Vasantharaj David, B. and V.V. Ramamurthy. *Elements of Economic Entomology*, Eighth Edition, Brillion Publishing, New York, 2016.
3. Ross. H.H. A *Text Book of Entomology*, John Wiley & Sons Inc., New York, 1965.
4. Chapman, R.F., S.J. Simpsonand A.E.Douglas. *The Insects: Structure and Function*, Fifth Edition, Cambridge University Press. 2013.
5. Imms, A.D., O.W.Richards and R.G. Davies (Eds.) IMMS' *General Textbook of Entomology*, *Volume I: Structure*, *Physiology and Development*, Volume 2: *Classification and Biology*, Springer Netherlands.
6. Daly, H.V., J.T. Doyen and P.R. Ehrlich. *Introduction to Insect Biology and Diversity*. Mc Graw-Hill Kogakusha Ltd., Tokyo, 1978.
7. Hill, D.S. *Agricultural Insect Pests of the Tropics and Their Control*. Cambridge University Press, New York, 1974.
8. Mani, M.S. 1982. *General Entomology*. Oxoford & IBH Publishing Co., pp-912.
9. Wigglesworth, V.B. *The Principles of Insect Physiology*, ELBS & Chapman and Hall, London. 1972.
10. Tembhare B.D. *Modern Entomology*. Himalaya Publishing House, India.

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	2	2	2	2	3	3	2	2	2	2
CO-2	3	2	2	2	2	2	2	2	2	2
CO-3	2	2	3	3	2	2	2	2	2	3
CO-4	3	3	3	3	2	2	3	2	2	3
CO-5	2	3	3	2	3	2	2	3	2	3
Ave.	2.4	2.4	2.6	2.4	2.4	2.2	2.2	2.2	2	2.6

Mapping	**<40%**	**≥ 40% and < 70%**	**≥ 70%**
Relation	**Low Level**	**Medium Level**	**High Level**
Scale	**1**	**2**	**3**

SEMESTER – I			
Elective I: Sericulture			
Course Code: 24PZOE12	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Objectives

- To impart about the significance of sericulture in India, the life cycle of the silkworm and various rearing methods.
- To develop skills to identify and manage common diseases and understand the role of sericulture in economics

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	recall the intricate life cycle of the silkworm, diverse rearing methods, and acquire the skills to tackle and solve complex biological challenges encountered in silk production.	**K1**
CO-2	discuss scientific findings on sericulture and become skilled in identifying and managing diseases and pests affecting mulberry plants and silkworm	**K2**
CO-3	demonstrate their proficiency in silkworm management to establish themselves as entrepreneurs in the sericulture sector.	**K3**
CO-4	examine environmental awareness and social responsibility in sericulture practices such as silkworm rearing, cocoon harvesting and transportation.	**K4**
CO-5	prove as economically independent individuals with a broad understanding of sericulture, actively contributing to human welfare and society.	**K5**

Unit I **Introduction** **(12 hrs)**

Introduction to sericulture – Sericulture in India and Tamil Nadu – role of Central Silk Board (CSB), Central Sericultural Research and Training Institute (CSRTI)

Unit II **Moriculture** **(12 hrs)**

Commercial varieties of mulberry – mulberry cultivation – cultivation practices – biofertilizers – foliar spray for mulberry – mulberry diseases– leaf blight , Mosaic disease, Root rot diseases, nematode and deficiency diseases – pests of mulberry – symptoms and control measures.

Unit III **Silkworm Rearing** **(12hrs)**

Types of mulberry silkworm – tasar, muga and eri-. Mulberry silkworm development – silkworm rearing – rearing house – rearing appliances - rearing operations - shelf rearing – floor rearing – shoot rearing. Silkworm diseases – flacherie, muscardine and grasserie. Pest – Indian uzifly – symptoms and control measures.

Unit IV **Cocoon Mounting and Reeling** **(12 hrs)**

Mounting methods - harvesting and transport of cocoon. Cocoon reeling – reeling operations, reeling appliances – cottage basin – filature units - by-products.

Unit V **Economics of Sericulture** **(12 hrs)**

Cocoon marketing - Grading of silk - Cost benefit ratio**,** Schemes for Sericulture development – NABARD, MSME, MUDRA- Employment generation in sericulture - Role of women in sericulture.

Books for Reference

1. Ganga, G. and J. Sulochana Chetty, *An Introduction to Sericulture*. Oxford &Publishing Co Pvt. Ltd. New Delhi, 1991.
2. Krishnaswamy S, *New Technology of Silkworm Rearing.* Published by Central SilkBoard, Bangalore, 1990.
3. Hisao Aruga, *Principles of Sericulture*. Published by Oxford & IBH Publishing Co.Pvt.Ltd., New Delhi, 1990.
4. Tammanna N. Sonwalker, *Hand Book of Silk Technology*. Published by Wiley EasternLtd, Madras, 1993.
5. Manjeet S. Jolly, *Appropriate Sericulture Techniques*. Published by Director, International Centre for Training and Research in Tropical Sericulture, Mysore, 1987.
6. Kamal Jaiswal, Sunil, P., Trivedi, B., Pandey, V. and P.N. Pandey, *Indian*

Sericulture.ALFA Publication, New Delhi, 2009.

7. Johnson, M and Kesari, M, *Sericulture*, Fifth edition 2015.

Web Resources

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

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	3	2	2	3	3	3	2	2
CO-2	2	3	3	2	2	2	3	2	2	2
CO-3	3	3	3	2	3	2	3	3	2	3
CO-4	2	2	2	3	2	2	2	2	3	2
CO-5	3	2	2	3	3	2	2	3	2	3
Ave.	2.6	2.6	2.6	2.4	2.4	2.2	2.6	2.6	2.2	2.4

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER – I			
Skill Enhancement Course I – Poultry Farming			
Course Code: 24PZOSE1	**Hrs/Week : 4**	**Hrs/Sem: 60**	**Credits: 3**

Objectives:

- To impart knowledge on the fundamentals of poultry management and advanced technologyin poultry industry.
- To create an avenue for self-employment and entrepreneurship.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	CL
CO1	demonstrate the present status of poultry industry in India and various practices in poultry farming	K1
CO2	plan and utilize the advanced farming practices to manage it in a profitable manner	K2
CO3	apply innovative technologies to manage the problems encountered in poultry keeping	K3
CO4	analyse the management techniques to handle various situations in poultry farming	K4
CO5	evaluate the strategies to get a rewarding carrier in poultry industry or self-employment to become entrepreneurs	K5

Unit I Poultry Industry (12 hrs.)

General introduction to poultry farming – Past and present scenario of poultry industry in India - Choosing commercial layers and broilers – Poultry housing – Deep litter system

Unit II Practical Aspects of Rearing Fowl (12 hrs.)

Management of chick, broiler, grower and layer, restricted feeding, grit feeding. Composition and nutritive value of eggs and poultry meat.

Unit III Management of Poultry (12 hrs.)

Summer management –winter management, forced moulting, lighting – debeaking of chick – growers – layers and broilers.

Unit IV Poultry Nutrition (12 hrs.)

Feed stuff for poultry, feed formulation– non-nutritive feed additives. Vitamins and essential inorganic elements.

Unit V Disease Management and Economics of Poultry Farming (12 hrs.)

Poultry diseases -viral-Ranikhet, Fowl pox, bacterial –Salmonellosis, Foul Cholera, fungal – Aspergillosis, Aflatoxicosis and parasitic diseases-Coccidiosis, external parasites (tick, mite), vaccination programme, Economics of poultry farming.

Books for Reference

1. Gnanamani, M.R. *Modern Aspects of Commercial Poultry Keeping*. Deepam Publication, Madurai, Tamil Nadu. 2010.
2. Gnanamani, M.R. *Profitable Poultry Farming*. sGiri Publication, Madurai. 2003.
3. Ensminger, M.R. *Poultry Science* CBS Publishers & Distrubutors Pvt. Ltd.New Delhi. 2015.
4. Ravindranathan. *A Text Book of Economic Zoology*. Wisdom Press, NewDelhi. 2013.
5. Prakash Malhotra. *Economic Zoology*. Adhyayan publishers, New Delhi. 2008.

Web Resources

1. http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf
2. https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	1	2	2	3	3	2	2	3	3
CO-2	3	2	3	3	3	3	2	3	2	2
CO-3	3	1	3	3	3	3	2	3	2	3
CO-4	3	3	2	1	3	3	3	2	2	3
CO-5	3	2	2	2	3	3	2	3	2	3
Ave.	3	1.8	2.4	2.2	3	3	2.2	2.6	2.2	2.8

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Core IV: Animal Physiology			
Course Code: 24PZOC21	**Hrs/Week : 6**	**Hrs/Sem: 90**	**Credits: 5**

Objectives

- To equip the students in the discipline of physiology, by imparting knowledge and understanding of the structure and function of human biological systems.
- To foster the understanding of fundamental mechanisms that operates in a living organism and how they interact.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	CL
CO-1	describe the structure and functions of different systems in animals and to develop professional skills	K1
CO-2	compare the anatomy, physiology and basic mechanism of the various parts of the body to cater the needs of academic and industrial research	K2
CO-3	demonstrate the organ systems and regulation of hormones to understand the metabolism of animals to solve complex biological problems	K3
CO-4	analyze the basic concepts and acquired knowledge pertaining to the anatomy, physiology and related disorders of organ systems of the body	K4
CO-5	evaluate the components and normal functioning of various organs towards the holistic growth and wellbeing of organisms	K5

Unit I **Digestive and Circulatory System** **(18 hrs)**

Digestive system - gastrointestinal secretary functions and the glands - role of gastrointestinal hormones. Structure of mammalian heart-cardiac cycle – cardiac output - control of heart beat - blood pressure and its regulation – related diseases (hypertension, hypotension, stroke).

Unit II **Respiratory System** **(18 hrs)**

Human respiration**:** Anatomy and physiology of the respiratory tract - transport of oxygen and carbon dioxide - regulation of respiration - artificial respiration - physiological response to oxygen deficient stress (diving, high altitude) and exercise.

Unit III **Neuromuscular and Sensory System** **(18 hrs)**

Nervous system: neurons – structure and types - nerve impulse propagation – concept of synapse - transmission of electrical and chemical synapse. Muscular system: Mechanism of muscle contraction - sliding filament theory. Sensory system: physiology of vision, hearing and equilibrium maintenance in man.

Unit IV **Excretory System** **(18 hrs)**

Human kidney: nephron – mechanism of urine formation – regulation of ionic and osmoregulation in invertebrates – Protozoa and crustaceans. Chordates – fishes - elasmobranchs, birds and mammals.

Unit V **Endocrinology** **(18 hrs)**

Basic mechanisms of hormone action - endocrine glands in mammal – pituitary, thyroid, adrenal and Islets of Langerhans – hormones, functions and disorders - role of hormones in menstrual cycle - pregnancy – parturition – lactation - hormones and neoplastic growth.

Books for Reference

1. Hoar. *General and Comparative Physiology*. New Delhi. Prentice. Hall of India Pvt Ltd, 1975.
2. Sembulingmam K, and Prema Sembulingam. *Essentials of Medical Physiology.* New Delhi: Jay Pee Brothers, 2006.
3. Kunt Schmidt-Nielsen K. *Animal Physiology, Adaptation and Environment*. Cambridge University Press. 1985.
4. Ladd Prosser C. *Comparative Animal Physiology*, Agra: Third edition. Satish Book Enterprise Book Sellers and Publishers, 1984.
5. Malcolm S. Gordon. *Animal Physiology Principles and Adaptations*. London: Third

Edition. Collier Mac Millan International Edition. Collier Mac Millan Publishers. 1984.

6. Nagabhushanam, R and M.S. Kodarkar. *Textbook of Animal Physiology*, New Delhi: Oxford and IBH Publishing Co., 1978.
7. Bentley P.J. *Comparative Vertebrate Endocrinology*, Delhi: First Edition Chand & Company Ltd, 1980.
8. Constance R. Martin. *Endocrine Physiology*, New York: First Edition. Oxford University Press, 1985.
9. Prakash S. Lohar. *Endocrinology – Hormones and Human Health*, Chennai: MJP Publishers, 2005.
10. Sawant S.C. *A Textbook of Human Physiology* New Delhi: Wisdom Press, 2015.
11. Anjali Mishra, Keshav Singh, Harendra Kumar Chauhan, Deepak Kumar Bhartiya. *Textbook of Animal Physiology*, Biotech Books, New Delhi, 2013.
12. Rastogi S.C. *Essentials of Animal Physiology*, New Age International Publishers Limited, New Delhi, 2019.

Web Resources:

1. https://swayam.gov.in/nd1_noc20_bt42/preview
2. https://www.classcentral.com/course/swayam-animal-physiology-12894
3. https://swayam.gov.in/nd1_noc20_hs33/preview

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	2	1	2	2	3	2	2	2	1
CO-2	2	3	2	2	3	2	3	2	3	2
CO-3	2	3	3	2	2	2	3	3	2	2
CO-4	3	2	2	3	1	3	2	2	3	2
CO-5	1	2	2	1	3	2	3	1	1	3
Ave.	2.2	2.4	2	2	2.2	2.4	2.6	2	2.2	2

Mapping	**<40%**	**≥ 40% and < 70%**	**≥ 70%**
Relation	**Low Level**	**Medium Level**	**High Level**
Scale	**1**	**2**	**3**

PRACTICALS

Hrs/Week: 2 **Course Code: 24PZOCR3** **Credit: 1**

1. Estimation of haemoglobin
2. Determination of erythrocyte sedimentation rate (ESR)
3. Detection of haemin crystals of blood
4. Salt loss/salt gain in a fish
5. Effect of temperature on oxygen consumption of fish
6. Urine analysis for sugar, albumin, urea and creatinine
7. Urine analysis for sediments
8. Assay of acid/ alkaline phosphatase enzyme
9. Chart/ slide/ photograph

a. Endocrine glands in man - Transverse section of pituitary, thyroid, pancreas and adrenal

b. Conditional reflex

c. Pregnancy test – demonstration

Books for Reference

1. Rastogi S.C. *Experimental Physiology*, New Delhi: Wiley Eastern Limited, 1982.
2. Nigam S.C. and Omkar. *Experimental Animal Physiology and Biochemistry*, New Delhi: New Age International (P) Limited, 2006.

SEMESTER II			
Core V : Cell and Molecular Biology			
Course Code: 24PZOC22	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Objective

- To develop knowledge on molecular machinery of living cell and become aware of the complexity and harmony of the cell
- To gain the comprehensive knowledge on the molecular structure of cells, cellular organelles and their coordinated functions

Course Outcome

Co.No	Upon completion of this course, students will be able to	CL
CO-1	define the general concepts of cell biology, structure and functions of intracellular organelles to acquire comprehensive knowledge for higher learning	K1
CO-2	explain the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance to molecular and cellular structures influencing functional features.	K2
CO-3	relate the importance of cell communication and signaling at the molecular level resulting in modulation of response at cellular level	K3
CO-4	analyze the interactions and regulations of various system of the cell including DNA, RNA and protein	K4
CO-5	evaluate the rapid advances in cell and molecular biology for a better understanding of onset of various diseases including cancer	K5

Unit I Cells and Organelles (15 Hrs)

Cell theory, Basic structure of prokaryotic and eukaryotic cells - Protoplasm and deutroplasm – Ultra structure and functions of intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum.

Unit II Plasma Membrane Organization and Functions (15 Hrs)

Plasma membrane structure and functions - Structure of model membrane (Fluid Mosaic), diffusion, membrane transport proteins (uniporter catalysed transport) – membrane electrical potential. Active transport by ATP-powered pumps Co - transport by symporters and antiporters,

Unit III Cell Communication and Cell Signaling (15 Hrs)

Signal receptors – Extracellular receptor, intracellular receptors – signaling mechanism - forms of intercellular signaling - signaling through G-protein coupled receptors - signal transduction pathways using second messengers - signaling from plasma membrane to nucleus

Unit IV Cell Division and Cell Cycle (15 Hrs)

Steps in cell cycle and control of cell cycle Mitosis and meiosis, Molecular biology of cell- Process of DNA replication, transcription and translation in prokaryotic and eukaryotic cells, molecular basis of mutation – transition-transversion – frame shift – induction of mutation – DNA repair mechanisms

Unit V Cancer Biology (15 Hrs)

Characteristic features of normal and cancer cells, Carcinogens - types and cancer induction, Metastasis, Oncogenes and tumor suppressor genes, apoptosis, therapeutic interventions of uncontrolled cell growth.

Books for Reference

1. Plopper, G., D. Sharp, and E. Sikorski. *Lewin's Cells* (Third Edition), Jones & Bartlett, New Delhi, pp-1056, 2015.
2. Plopper, G. *Principles of Cell Biology*, Jones & Bartlett, Maryland, pp-510. 2013
3. Karp, G. *Cell Biology* (Sixth Edition), John Wiley & Sons, Singapore, pp-765.2010
4. Lodish, H., C. A. Kaiser, A. Bretscher, *et al*., *Molecular Cell Biology* (Seventh Edition), Macmillan, England, pp-1154.2013.
5. De Robertis, E.D.P. and E. M. F. De Robertis. *Cell and Molecular Biology*. Info-Med, Hong Kong, pp-734.1987.
6. Abbas, A. K., A. H. Lichtman and S. Pillai, *Cell and Molecular Immunology* (Sixth Edition), Saunders, Philadelphia, pp-566.2007.
7. Loewy, A.G., P. Siekevitz and J. R. Menninger, *et al*., *Cell Structure and Function* (Third Edition), Saunders, Philadelphia, pp-947.1991.
8. Watson, J. D., N.H. Hopkins, J.W. Roberts, *et al*., *Molecular Biology of the Gene* (Fourth Edition), Benjamin/Cummings, California, pp-1163.1987.
9. Han, S. S. and J. Holmstedt. 1979, Cell Biology, Mc Graw Hill, pp-319
10. Alberts, B., A. Johnson, J. Lewis, *et al*., *Molecular Biology of the Cell* (Sixth Edition), Garland Science, New York, pp-1342.2015.
11. Clark, D.P., *Molecular Biology*, Elsevier, China, pp-784.2005.
12. Tropp, B. *Molecular Biology Genes to Proteins* (Third Edition), Jones & Bartlett, US, pp-1000. 2008.

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	3	3	3	1	1	3	1	3	2	1
CO-2	3	2	3	1	1	3	1	1	3	2
CO-3	1	3	2	2	1	1	2	1	2	1
CO-4	2	2	3	3	1	3	2	3	3	1
CO-5	2	3	1	2	3	1	3	2	3	3
Ave.	2.2	2.6	2.4	1.8	1.4	2.2	1.8	2	2.6	1.6

Mapping	**<40%**	**≥ 40% and < 70%**	**≥ 70%**
Relation	**Low Level**	**Medium Level**	**High Level**
Scale	**1**	**2**	**3**

Practicals

Hours/week :2 **Course Code :24PZOCR4** **Credit :1**

1. Mitosis in root meristematic cells of plants
2. Identification of various stages of meiosis in the testes of grasshopper
3. Detection of polytene chromosome in salivary gland cells of the larvae of the Chironomus
4. Detection of sex chromatin
5. Identification of blood cells in the haemolymph of the cockroach
6. Preparation of human blood smear.
7. Observation of blood smear of frog.
8. Study of stained preparation of striated muscle fibres in cockroach
9. Observation of sarcomere, columnar epithelial cells and ciliated epithelial cells.
10. Observation of different types of tissues - bone, hyaline cartilage, liver, kidney and nervous tissue

Books for Reference

1. Nagesh Rao K.M.S. *Histology*. New Delhi: CBS Publishers and Distributors. 2007.
2. Shah and Chinoy, N.J. *Essential Techniques in Cell Biology*. Ahmedabad: Anada Book Depot. Educational Publishers. 2007
3. Goswaml, H.K. Practical Cytology, *Applied Genetics and Biostatistics*. Bombay:Himalaya Publishing House.1986.

SEMESTER II			
Core VI: Genetics and Evolution			
Course Code: 24PZOC23	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 4**

Objectives

- To explore the genetic recombination, genetic disorders, evolutionary theories, and the prospective future of human evolution for comprehensive learning.
- To emphasize the societal relevance and significance of genetics and evolutionary principles.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	CL
CO-1	recall fundamental genetic principles from human karyotype analysis, chromosome aberrations, microbial genetics, population genetics and evolutionary concepts.	**K1**
CO-2	discuss genetics and evolutionary phenomena to cater to the varied requirements within academic sectors, fostering adaptability to navigate the ever - evolving biological models.	**K2**
CO-3	apply scientific methods to generate insights for addressing genetic disorders, fostering an environment for animals to evolve into new species, and contribute innovative solutions to environmental challenges.	**K3**
CO-4	compare genetic theories with modern advancements in genetic counselling, pharmacogenetics and evolutionary studies.	**K4**
CO-5	assess advancements in the field of genetics, gauging their significant contributions to enhancing societal well-being through diverse means.	**K5**

Unit I Chromosomes and Genetic Recombination (15 Hrs)

Introduction - human karyotype analysis – Aberration in chromosome structure - Morgan's experiments - theories and molecular mechanism of crossing over – construction of chromosome map **–** three point test cross (Drosophila) - chromosome banding and chromosome painting techniques.

Unit II Microbial Genetics (15 Hrs)

Recombination in bacteria – conjugation – transformation – transduction – sexduction – transposons – families of transposable elements in bacteria – Modes of transposition – medical significance of transposons.

Unit III Population Genetics and Human Genetics (15 Hrs)

Gene pool concept – gene and genotype frequencies – Hardy and Weinberg law - equilibrium and algebraic proof- estimation of equilibrium gene frequencies for complete dominance, co-dominance and multiple alleles. Neurodegenerative diseases – Alzheimer's, Huntington's disease – Genes in pedigree – dermatoglyphics, diagnostic features - Pharmacogenetics – drug metabolism, genetic variation in the effect of drugs - Genetic counselling.

Unit IV **Evolutionary Concepts** **(15 Hrs)**

Lamarck and Darwin – concepts of variation, adaptation, struggle, fitness and natural selection Neo – Lamarkism, Neo- Darwinism - experimental evidences - Natural selection- stabilizing, directional and diversifying selection.

Unit V **Speciation** **(15 Hrs)**

Species - modes of speciation. Sexual selection and co evolution. Genetic drift-evolutionary significance - isolating mechanisms and their significance – Simpson's adaptive grid concept– Evolution of man – Biological, cultural and future evolution.

Books for Reference

1. Strickberger, M.W. *Genetics*, 3rd edition, Maxwell Macmillan International Edition, New York, 1985.
2. Gardner, Simmons and Snustad. *Principles of Genetics,* 6th edition Prentice Hall. Inc.NewYor, 1991
3. Klug, W.S. and M.R. Cummings. *Concepts of Genetics,* 6th edition Prentice Hall. Inc. New York, 2000
4. Emmanuel, C., S, Ignacimuthu, and S. Vincent. *Applied Genetics – Recent Trends and Techniques,* MJP Publishers, Chennai, 2009.
5. Amita Sarkar. *A Text Book of Human Genetics,* Wisdom Press, New Delhi, 2011
6. Kreb, J.E., S. Goldstein and T. Kilpatrick, *Genes,* 10th edition. Jones Bartlett Publishers, USA. 2011.
7. Ujjwala Deshmukh, *Cytogenetics and Evolution,* Dominant Publishers and Distributors. New Delhi, 2005
8. Gurbacham S. and L. Miglani. *Essentials of Molecular Genetics*, Narosa Publishing House, New Delhi, 2015.
9. Ledyard Stebbins. *Processes of Organic Evolution*, Prentice Hall of India, 1970.
10. Ernst Mayr. *Populations, Species and Evolution. An Abridgment of Animal Species and Evolution,* Harvard University press, Garden Street, Cambridge, 1970.
11. Dobzshansky, Francis J., G. Ayala and W. Ledyard Stebbins James, *Valentine Evolution*. Surjeet Publications, Delhi. 1973.

Web Resources

1. https://onlinecourses.swayam2.ac.in/cec21_bt02/preview
2. https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/the-genetic-code
3. https://onlinelibrary.wiley.com/journal/15585646
4. http://darwin-online.org.uk/

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PSO-1**	**PSO-2**	**PSO-3**	**PSO-4**	**PSO-5**
CO-1	**3**	**2**	**1**	**2**	**1**	**3**	**2**	**3**	**1**	**1**
CO-2	**3**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**2**	**2**
CO-3	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**3**
CO-4	**3**	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**3**	**2**
CO-5	**3**	**3**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**3**
Ave.	**3.0**	**2.6**	**2.0**	**2,0**	**2.6**	**3.0**	**2.8**	**2.8**	**2.2**	**2.2**

Mapping	**<40%**	**≥ 40% and < 70%**	**≥ 70%**
Relation	**Low Level**	**Medium Level**	**High Level**
Scale	**1**	**2**	**3**

Practicals

Hours/Week: 2 **Course Code: 24PZOCR4** **Credit: 1**

1. Construction of genetic map for a given three point test cross.
2. Solving genetic problem using probability and chi- square test
3. Observation of common mutants of Drosophila
4. Survey of simple Mendelian traits and ABO blood group in the class population and estimation of gene and genotype frequencies based on Hardy – Weinberg law.
5. Demonstration of role of random genetic drift in small populations using simulation (beads)
6. Analysis of dermatoglyphic data (finger print) of the class population.
7. Construction of pedigree
8. Bacterial conjugation (chart).
9. Industrial melanism- Peppered moth
10. Simpson's adaptive grid

Books for Reference

1. Michael Breitenback. *Experimental Genetics I – Biophysics. shg. ac /at/ home.htm*1973
2. William. D. Stansfield. Schaum's Outline Series. *Theory and Problems of Genetics.* Second Edition. Mc Graw Hill Book Company, USA 1977.

SEMESTER II			
Elective II: Research Methodology			
Course Code: 24PZOE21	**Hrs/Week : 4**	**Hrs/Sem: 60**	**Credits: 3**

Objectives

- To impart knowledge on various techniques used in biological research and develop the skill of writing and interpreting a research report.
- To understand the basic principle, methodology and applications of widely used instruments in biological sciences.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	identify and acquire knowledge on norms, principle, components, applications of different laboratory instruments, techniques and in research writing	K1
CO-2	explain various techniques and skill used to gain insight into biological processes and research by understanding vital connection towards holistic development	K2
CO-3	relate the broad range of scientific tools, concepts, theories and techniques to solve the research problems and designing	K3
CO-4	analyze the expertise and knowledge acquired in various biological, chemical techniques used for imaging of substances and in thesis designing	K4
CO-5	evaluate critical thinking and various approach in the biotechniques, design and implementation of an experiment towards the scientific development and empowerment	K5

Unit I **Good Laboratory Practices and Spectroscopic Techniques (12 hrs)**

Best laboratory practices - norms to be followed in the laboratory. Construction, applications and principles – UV – visible spectrophotometer, FTIR, flame photometer - atomic absorption and emission spectrophotometer, ESR and NMR.

Unit II **Histology and Histochemistry** **(12 hrs)**

Preparation of whole mount and sectioning, staining, mounting and preparation of permanent slides – micrometry, Cyto and Histochemical techniques - Demonstration of DNA by Feulgen and Rossenbeck's nuclear reaction method.

Unit III **Techniques of Microscopy** **(12 hrs)**

Principle, instrumentation and applications of Electron microscope – types (SEM, TEM) - Phase contrast, Polarization, Fluorescence, atomic force and magnetic force microscope.

Unit IV **Principle and Applications of Biotechniques** **(12 hrs)**

Principle and applications of centrifuge – ultracentrifuge – density gradient centrifugation, Chromatography – HPLC, TLC, Electrophoresis: SDS-PAGE, isoelectric focusing.

Unit V **Thesis Designing** **(12 hrs)**

Introduction - literature collection - Internet and e-journals - literature citation - APA formatting style - experimental design - thesis formatting and typing - interpretation - Plagiarism – types, Plagiarism Checker. Calculation of citation index (Google Scholar, Scopus and Web of Science).

Books for Reference

1. Palanichamy S. and M. Shanmugavelu. *Research Methods in Biological Sciences*. Palani : Palani Paramount Publication.1997.
2. Gurumani. *Research Methodology for Biological Sciences*. Chennai: M.J.P. Publishers. 2011.
3. Veerakumari. L. *Bioinstrumentatio*n. Chennai: M.J.P Publishers. 2007.
4. Aparna Mathur. *Laboratory Instrumentation*. New Delhi: Black Prints. 2013.
5. Chinmoy Goswami, Abhijit Paintal and Rabindra Narain. *Hand Book of Bioinstrumentation.* Delhi: South Anarkali. 2011.
6. Debbie Holmes Peter Moody and Diana Dine. *Research Methods for the Biosciences.* U.K. Oxford University Press. 2006.
7. Rabindra Narain. *Practical Immunology*. New Delhi: Wisdom Press. 2012.
8. Rodney F.Boyer. *Biochemistry Laboratory: Modern Theory and Techniques*, Second Edition, Prentice Hall. 2012.

9. Pearse, A.G. *Histochemistry: Theoretical and Applied*, Vol. I, Third Edition, J & A Churchill Ltd. 1968.
10. Lillie, R.D. *Histopathologic Techniques and Practical Histochemistry*, Second Edition, Blakiston, New York. 1954.
11. Hoppert, M. *Microscopic Techniques in Biotechnology*, Wiley-VCH GmbH, Weinheim, Germany. 2003.

Web Resources:

1. https://www.ibiology.org/biology-techniques/
2. http://www.life.uiuc.edu/molbio/geldigest/electro.html
3. https://www.nature.com/subjects/biological-techniques
4. https://www.ibiology.org

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	1	3	3	1	2	1	2	2	1
CO-2	1	3	2	1	3	2	3	2	2	3
CO-3	2	1	3	2	2	3	3	3	1	1
CO-4	3	1	2	3	1	3	3	1	3	2
CO-5	1	3	3	2	3	1	2	3	3	3
Ave.	2.0	1.8	2.6	2.2	2.0	2.2	2.4	2.2	2.2	2.0

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Elective II: Nanotechnology			
Course Code: 24PZOE22	**Hrs/Week : 4**	**Hrs/Sem: 60**	**Credits: 3**

Objectives

- To understand the fundamental concept, nature and properties of nanomaterials.
- To provide insight into the application of nanomaterials and nanotechnology in various domains of agriculture, health and environment.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	show the fundamental concepts and techniques of nanotechnology, nanomaterials and its applications	K1
CO-2	infer the acquired knowledge and skills gained in the classification and applications of nanotechnology, nanomaterials to cater the industrial needs	K2
CO-3	compile the properties, techniques and importance of nanobiomaterials in biomedical and tissue engineering to solve the research issues	K3
CO-4	examine the comprehensive knowledge on the major aspects of nanobiotechnology in career development, higher education, research and development	K4
CO-5	evaluate the various approaches of nanotechnology in the progress of scientific development towards the society	K5

Unit I **Fundamentals of Nanotechnology** **(12 hrs)**

Introduction to Nano-science and Nano-technology, Nano-scale material. Nano-metals, Chalcogenides and Boron Nitrite and Carbon Nanomaterials. Nanosized metals and alloys, semiconductors, ceramics – a comparison with respective bulk materials, organic semiconductors.

Unit II **Classification and Nomenclature of Nanomaterials** **(12 hrs)**

Nanocrystals and their applications - nanofactories - nanobiosensors - optical biosensors - DNA biosensors - Quantum dots. Quantum wells, quantum rods, quantum wires, quantum rings; bulk nanostructured nanocomposites, nanomachines and devices. Basic concept; nanoparticles; Applications: Nanobiomechanics, nanoparticle–biomolecule conjugate, nanomedicines, nanosubmarine and nanozymes.

Unit III **Nanobiomaterials and Biocompatibility** **(12 hrs)**

Surface and bulk properties of bio materials – Nanobiomaterials –Nanoceramics – Nanopolymers – Nano Silica – Hydroxy apatite – Carbon based nanomaterials, Surface modification – textured and porous materials – Surface immobilized biomolecules – Cell-biomaterial interactions – immune response – *in vitro* and *in vivo* assessment of tissue compatibility.

Unit IV **Nanotechnology for Environment and Biomedical Applications** **(12 hrs)**

Nanomedicines and drug delivery systems - health and environment impacts of nanotechnology - pros and cons of nanotechnology. Biomaterials for tissue engineering - Biomaterials: ceramics, polymers (synthetic and natural). Biodegradable materials: synthesis and characterization, classification on the basis of origin and material properties. Applications of nanotechnology for environmental remediation.

Unit V Application of Tissue Engineering (12 hrs)

Application in stem cell tissue engineering, cardiac cells engineering, neural cell engineering, cartilage, bone, vascular cells, skin tissue engineering and ligament. Stem cell therapies. Nanotechnology-based approaches in the treatment of injuries to tendons and ligaments - Progress in the use of electrospinning processing techniques for fabricating nanofiber scaffolds for neural applications.

Books for Reference

1. Subbiah Balaji. *Nanobiotechnology,* MJP Publishers, Chennai. 2010.
2. Murthy B.S., P. Shankar and James Murday. *Text book of Nanoscience and Nanotechnology*. Universities Press (India) Private Limited , Hyderabad. 2012.
3. Niemeyer, C.M., C.A. Mirkin. *Nano Biotechnology:Concepts Applications and Prespectives,* Wiley – VCH, ISBN: 3527306587. 2004.
4. Niemeyer C. M. *Nanobiotechnology: Concepts, Applications and Perspectives*, Wiley – VCH. 2006.
5. David S Goodsell. *Bionanotechnology*, John Wiley & Sons. 2004.
6. Debasis Bagchi, Manashi Bagchi, Hiroyoshi Moriyama, Fereidoon Shahidi. *Nanotechnology: A Revolution in Food, Biomedical and Health Sciences*, Wiley-Blackwell. 2013.

Web Resources:

1. https://www.my-mooc.com/en/categorie/nanotechnology
2. https://www.classcentral.com/subject/nanotechnology
3. https://elearninguoa.org/course/health-nanotechnology-nanomedicine/nanotechnology-and-nanomedicine

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	2	1	2	1	1	2	1	1	2	1
CO-2	3	3	3	2	1	3	3	3	2	2
CO-3	1	2	3	2	2	2	2	3	1	2
CO-4	3	3	3	3	3	2	3	2	1	3
CO-5	2	1	1	3	3	1	2	2	3	3
Ave.	2.2	2.0	2.4	2.2	2.0	2.0	2.2	2.2	1.8	2.2

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3

SEMESTER II			
Skill Enhancement Course II: Aquaculture			
Course Code: 24PZOSE2	**Hrs / Week : 4**	**Hrs / Sem: 60**	**Credits: 3**

Objectives:

- To comprehensively explore aquaculture's global significance, India's current standing, and various culture systems and techniques employed in the field.
- To empower students with essential expertise in aquaculture, focusing on nutrition, disease management, economics, and career prospects within the sector.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	C L
CO-1	recall aquaculture's global significance, diverse culture systems and techniques, nutrition, and economic aspects, fostering their professional development in the field.	K1
CO-2	discuss methodologies relevant to aquaculture, focusing on health management practices for various aquatic species, preparing to meet entrepreneurial and industrial demands.	K2
CO-3	demonstrate observed techniques in aquaculture to address selection, construction, and disease management of fish farms, contributing to innovative research solution	K3
CO-4	compare their knowledge of culture techniques and management of aquatic animals across diverse domains, fostering advancements in aquaculture.	K4
CO- 5	support their comprehension of aquaculture techniques and management strategies, with an extension to understanding societal contributions and employment opportunities in the field.	K5

Unit I **Introduction to Aquaculture** **(12 hrs)**

Aquaculture: Importance of aquaculture, Global scenario, Present status in India. Prospects and scope. Selection of site, construction of fish farm, soil chemistry, Construction of different types of fish ponds.

Unit II **Types of Culture System** **(12 hrs)**

Extensive, Semi-intensive and Intensive systems, Monoculture, composite fish culture , sewage – fed fish culture, integrated fish culture – pig cum fish culture, poultry cum fish culture, cattle cum fish culture, paddy cum fish culture, cage and pen culture.

Unit III **Culture Techniques** **(12hrs)**

Culture of Indian major carps, murrel, milk fish. Culture of fresh water prawn Mariculture: Culture of marine prawn, Pearl oyster , Edible Oyster, air breathing fishes, sea weed .Water quality requirements for Aquaculture.

Unit IV **Nutrition and Health Management** **(12 hrs)**

Culture of fish feed organisms: Live feed-diatoms, rotifers, Artemia, Artificial feed formulation and management,. Bacterial diseases (gill rot and Furunculosis), viral diseases (Epizootic Ulcerative Syndrome and Erythrocyticnecrosis), fungal diseases (Saprolegniasis and Branchiomycosis), Nutritional deficiency diseases.

Unit V **Economics of Aquaculture** **(12 hrs)**

Fish preservation and processing -by products of fishing industry -fish marketing, -involvement of government organizations in marketing.Role of CMFRI, NIOT,CIBA and NABARD. employment opportunities in Aquaculture

Books for Reference

1. Dubey, S. K. and Bandand Ghosh. *Fish Biotechnology*. Wisdom Press, New Delhi. 2012.
2. Amita Saxena, *Fisheries Economics*. Daya Publishing House, New Delhi. 2011.
3. Agnihotri. S. B. *Aquaculture Management and Technology*. Swastik Publication, Delhi. 2013.
4. Felix, S. *Marine and Aquaculture Biotechnology*. Agrobios, Jodhpur, India. 2010.
5. Santhanam, R., N. Ramanathan and G. Jegathesan. *Coastal Aquaculture in India*. 1stedn. CBS Publishers, Delhi.1990.

6. Shagufta. *Fish Health and Diseases.* APH Publishing., Corporation, New Delhi. 2012.
7. *Biotechnology and Genetics.* Mangalam Publishers & Distributors, Delhi.2013.
8. ChandraSekar. Y.S. *Fish Nutrition in Aquaculture*. Swasthik Publishers & Distributers, Delhi. 2012.
9. Rajendra Kumar Rath. *Freshwater Aquaculture*. Scientific Publishers, Jodhpur. 2011.
10. Jayakumar.S. *Basics of Fish Farming for The Beginners*.Notion Press, Chennai, 2020
11. Dr.R.K. Singh. *Fishery Resources*. Pearl Books, New Delhi. 2013.

PSO Relation Matrix

Course Outcomes	Programme Outcomes (PO)					Programme Specific Outcomes (PSO)				
	PO-1	PO-2	PO-3	PO-4	PO-5	PSO-1	PSO-2	PSO-3	PSO-4	PSO-5
CO-1	3	3	2	3	2	3	3	3	3	2
CO-2	3	3	3	3	3	3	3	2	2	3
CO-3	2	2	3	3	2	3	2	3	2	2
CO-4	2	3	2	3	1	3	2	2	3	3
CO-5	3	3	3	3	3	3	3	3	3	3
Ave.	2.6	2.8	2.6	3.0	2.2	3.0	2.6	2.6	2.6	2.6

Mapping	<40%	≥ 40% and < 70%	≥ 70%
Relation	Low Level	Medium Level	High Level
Scale	1	2	3