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. 2023)

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
Department of Zoology

PG Course Structure (w.e.f.2023)

Semester– I

Course	Course Code	Course Title	Contact Hours/ Week	Credits	Max. Marks		
					CIA	ESE	Total
Core I	23PZOC11	Structure and Function of Invertebrates	7	5	25	75	100
Core II	23PZOC12	Comparative Anatomy of Vertebrates	7	5	25	75	100
Core Practical I	23PZOCR1	Lab Course in Invertebrates and Vertebrates	6	4	40	60	100
Discipline Specific Elective I	23PZOE11/ 23PZOE12	**Molecules and their interaction relevant to Biology**/ Nutrition and Dietetics	5	3	25	75	100
Discipline Specific Elective II	23PZOE13/ 23PZOE14	**Biostatistics**/ Ornamental Fish Culture	5	3	25	75	100
		Total	**30**	**20**			

Semester–II

Course	Course Code	Course Title	Contact Hours /Week	Credits	Max Marks		
					CIA	ESE	Total
Core III	23PZOC21	Cell and Molecular Biology	5	5	25	75	100
Core IV	23PZOC22	Genetics and Evolution	5	5	25	75	100
Core Practical II	23PZOCR2	Cell and Molecular Biology Genetics and Evolution	4	2	40	60	100
Discipline Specific Elective III	23PZOE21/ 23PZOE22	**Economic Entomology**/ Parasitology	4	3	25	75	100
Discipline Specific Elective IV	23PZOE23/ 23PZOE24	**Research Methodology**/ Nanotechnology	4	3	25	75	100
Discipline Specific Elective Practical I	23PZOER1	Economic Entomology Research Methodology	4	2	40	60	100
Skill Enhancement Course I (Discipline Specific)	23PZOSE1	Poultry Farming	4	2	25	75	100
MOOC (Compulsory)				+2			
Total			**30**	**22+2**			

Semester –III

Course	Course Code	Course Title	Contact Hours /Week	Credits	Max . Marks		
					CIA	ESE	Total
Core V	23PZOC31	Animal Physiology	6	5	25	75	100
Core VI	23PZOC32	Immunology	5	5	25	75	100
Core VII	23PZOC33	Microbiology	5	5	25	75	100
Core Practical III	23PZOCR3	Animal Physiology	2	1	40	60	100
Core Practical IV	23PZOCR4	Immunology, Microbiology	4	2	40	60	100
Discipline Specific Elective V	23PZOE31/ 23PZOE32	**Applied Biotechnology**/ Animal Behaviour	4	3	25 25	75 75	100 100
Skill Enhancement Course II (Discipline Specific)	23PZOSE2	Dairy Farming	4	3	25	75	100
Internship / Self Study (Optional)	23PZOI31/ 23PZOSS1	Zoology for Competitive Examination		+2		50	50
Total			**30**	**24**+2			

Semester– IV

Course	Course Code	Course Title	Contact Hours /Week	Credits	Max. Marks		
					CIA	ESE	Total
Core VIII	23PZOC41	Marine Biotechnology	5	5	25	75	100
Core IX	23PZOC42	Developmental Zoology	5	5	25	75	100
Core X	23PZOC43	Conservation Biology	4	4	25	75	100
Core Practical V	23PZOCR5	Marine Biotechnology	2	1	40	60	100
Core Practical VI	23PZOCR6	Developmental Zoology, Conservation Biology	4	2	40	60	100
Discipline Specific Elective VI	23PZOE41/ 23PZOE42	**Aquaculture**/ Ornithology	4	3	25 25	75 75	100 100
Core XI (Project)	23PZOP41	Project and Viva Voce	6	4	40	60	100
Total			**30**	**24**			

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: Structure and Function of Invertebrates			
Course. Code: 23PZOC11	**Hrs/Week: 7**	**Hrs/Sem: 90**	**Credits: 5**

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	Cognitive Level
CO-1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	K1
CO-2	Understand the evolutionary process. All are linked in a sequence of life patterns.	K2
CO-3	Apply this for pre-professional work in aquaculture and conservation of life forms.	K3
CO-4	Analyze what lies beyond our present knowledge of life process.	K4
CO-5	Evaluate and to create the perfect phylogenetic relationship in classification.	K5

Unit I Nomenclature (18Hrs)

Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; Newtrends in taxonomy

UNIT II Coelom and Locomotion (18Hrs)

Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomiaand Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata

UNIT III Digestion and Respiration (18Hrs)

Nutrition and Digestion: Patterns of feeding and digestion in lowermetazoan; 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** **(18Hrs)**

Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malphigian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and lnsecta) and Mollusca (Cephalopoda); Trends in neural evolution

UNIT V **Invertebrate larvae and Minor Phyla** **(18Hrs)**

Invertebrate larvae: Larval forms of free living invertebrates - Larval forms of parasites; Strategies and evolutionary significance of larval forms. Minor Phyla:Concept and significance; Organization and general characters

Text Book

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.

Books for Reference

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/

1. Lal, S.S. *A Text Book of Practical Zoology: Invertebrate*, Rastogi, Meerut. 2005.
2. Sinha, Chatterjee and Chattopadhyay, *Advanced Practical Zoology*, Books & Allied Ltd; 3rd Revised edition, 1070 pp. 2014

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	3	2	2	**3**	2	2
CO-2	2	**1**	2	2	1	3	2	3	3	2
CO-3	3	3	3	3	**2**	3	3	**2**	2	2
CO-4	3	2	2	2	3	3	3	3	3	2
CO-5	3	3	3	2	3	2	2	**2**	3	**3**
Ave.	2.7	2.5	2.7	2.2	**2.5**	**2.7**	**2.5**	**2.7**	2.7	**2.1**

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

Lab Course in Invertebrates .

Hrs/Week: 3 **Course. Code: 23PZOCR1** **Credits: 2**

INVERTEBRATES

Dissection

Earthworm : Nervous system
Pila : Digestive and nervous systems
Sepia : Nervous system
Cockroach : Nervous system
Grasshopper : Digestive system and mouth parts
Prawn : Appendages, nervous and digestive systems
Crab : Nervous system

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

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

Spotters

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

Mounting

Earthworm : Body setae
Pila : Radula
Cockroach : Mouth parts
Grasshopper : Mouth parts

Text Books:

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 II : Comparative Anatomy of Vertebrates			
Course Code: 23PZOC12	**Hrs/Week:7**	**Hrs/Sem:105**	**Credits: 5**

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 and Morphology of Vertebrates** **(21Hrs)**

Origin of vertebrates: Concept of Protochordata; The nature of vertebrate morphology; Definition, scope and relation to other disciplines; Importance of the study of vertebrate morphology.

Unit II **Classification of Vertebrates and Integumentary System** **(21Hrs)**

Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.

Unit III **Circulatory System and Respiratory System** **(21Hrs)**

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

Unit IV **Skeletal System and Urinogenital System** **(21Hrs)**

Skeletal system: Form, function, body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrate series.

Unit V **Sense Organs and Nervous System** **(21Hrs)**

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

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

Lab Course in Vertebrates

Hrs/Week: 3 **Course code: 23PZOCR1** **Credits: 2**

I. Study the nervous system of Indian dog shark - Dissection

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

II. 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)

III. Study of the different types of scales in fishes

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

III. Study of the frog skeleton system (Representative samples)

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

IV. Mounting

1. Weberian ossicles of fish

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			
Discipline Specific Elective I Molecules and their Interaction Relevant to Biology			
Course Code: 23PZOE11	**Hrs/Week : 5**	**Hrs/Sem: 75**	**Credits: 3**

Objectives

- To give students basic concepts of biochemistry and its nature of interdisciplinary importance.
- To let students understand the physical and chemical properties of molecules, and theirstatus of occurrence in biological system.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO-1	compile the structure, properties, metabolism and bioenergetics of biomolecules	K1
CO-2	discuss the fundamentals of biophysics, biochemistry and the applications of structural conformation of biopolymers	K2
CO-3	apply the insights of biomolecules and biological buffers in real life situations, research and industry	K3
CO-4	analyse the importance of stabilizing interactions in biomolecules, bonds and hydrophobic interactions in solving the biochemical problem	K4
CO-5	assess and relate the concepts of chemistry to biology to manage metabolic errors health issues and handle research activities	K5

Unit I **Basics of Biophysical Chemistry and Biochemistry** **(15 Hrs)**

Structure of atoms, molecules and chemical bonds - Principles of biophysicalchemistry - pH, buffer, reaction kinetics, thermodynamics and colligative properties.

Unit II **Biomolecular Interactions and their Properties** **(15 Hrs)**

Stabilizing interactions Vander Waals, electrostatic, hydrogen bonding and hydrophobic interaction - Composition, structure, metabolism and function of biomolecules - carbohydrates, lipids, proteins, nucleic acids and vitamins.

Unit III **Bioenergetics and Enzymology** **(15 Hrs)**

Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers - Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes.

Unit IV **Structural Conformation of Proteins and Nucleic Acids** **(15 Hrs)**

Conformation of proteins - Ramachandran plot, secondary, tertiary and quaternary structure; domains; motifs and folds - Conformation of nucleic acids - A-, B-, Z-DNA, t-RNA, micro-RNA.

Unit V **Stabilizing Interactions in Biomolecules** **(15 Hrs)**

Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage.

Books for Reference

1. Berg, J. M., J. L. Tymoczko and L. Stryer. *Biochemistry*. 5th Ed., W.H. Freeman &Co., New York, pp-1050. 2002
2. Kuchel P.W. and G. B. Ralston. *Biochemistry*. McGraw Hill (India) Private Limited,UP, pp-580. 2008.
3. McKee T. and J. R. McKee. *Biochemistry*: *The Molecular Basis of Life*. (7thEdition). Oxford University Press, US, pp-793. 2012.
4. Nelson D.L. and M.M. Cox. *Lehninger's Principles of Biochemistry*. (6th Edition). W. H. Freeman Publishers, New York, pp-1158. 2012.
5. Satyanarayana U. and U. Chakrapani, *Biochemistry*. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695. 2006.

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

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	1	1	3	2	2	3	2
CO-2	3	1	3	2	2	3	2	3	2	3
CO-3	3	2	3	3	3	3	2	3	2	2
CO-4	2	2	3	2	2	3	2	3	3	2
CO-5	3	3	3	2	1	3	2	3	2	3
Ave.	3	1.8	2.8	1.8	1.8	3	2	2.8	2.4	2.4

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

SEMESTER I			
Discipline Specific Elective I : Nutrition and Dietetics			
Course Code: 23PZOE12	**Hrs/Week : 5**	**Hrs/Sem: 75**	**Credits: 3**

Objectives

- To familiarize the students with fundamentals of food and nutrition.
- To equip the students to plan dietary requirements for a healthy lifestyle.

Course Outcome

On the successful completion of the course, student will be able to		**CL**
CO-1	explain the basic concepts of nutrition and dietetics	K1
CO-2	summarize the sources and functions of micro and macro nutrients	K2
CO-3	relate the nutritional significance and health benefits of basic food groups	K3
CO-4	analyze dietary requirement of different groups of individuals	K4
CO-5	evaluate the etiologic and clinical features of nutrition related disorders and their dietary management.	K5

Unit I **Nutrition** **(15 hrs)**

Definition of Food, Nutrition, Nutrient, Nutritional status, Balance diet, Malnutrition, Energy (Unit of energy – Joule, Kilocalorie)- B.M.R: Definition, factors affecting B.M.R. and Total Energy Requirement (Calculation of energy of individuals).

Unit II **Macronutrients and Micronutrients** **(15 hrs)**

Carbohydrate, Protein, Fat, Vitamins and Minerals (calcium, phosphorus, sodium, potassium, iron, iodine, fluorine)- sources, classification, functions, deficiencies of these nutrients..

Unit III **Basic Food Groups** **(15 hrs)**

Nutritional significance of cereals, pulses, milk, meat, fish, vegetable, egg, nuts, oils, sugar- Functions of water and dietary fiber

.

Unit IV **Dietetics** **(15 hrs)**

Definition of a balanced diet-Goals of Diet Therapy, Principles and objectives of meal planning. Diet for an infant (Breast feeding versus Bottle feeding)- Normal male and female -Routine hospital diets –Regular, soft, full fluid, clear fluid diet. Specially modified therapeutic diets

Unit V **Dietary Management of Diseases** **(15 hrs)**

Causes, symptoms and Dietary management of diseases: Obesity and underweight- Diarrhoea, Constipation, Jaundice-Anaemia: Definition, causes, classification, and dietary management of Nutritional anaemia. Hypertension, Atherosclerosis and Diabetes mellitus: Definition, causes, types, risk factors, symptoms and dietary management.

Books for Reference

1. Mudambi, S.R. and Rajagopal, M.V. *Fundamentals of Foods, Nutrition and Diet Therapy*; Fifth Ed; New Age International Publishers. 2007.
2. Srilakshmi, B. *Food Science; Fourth Ed;* New Age International (P) Ltd. 2007.
3. Swaminathan, M. *Handbook of Food and Nutrition*; Fifth Ed; BAPPCO. 1986.
4. Bamji, M.S.; Rao, N.P. and Reddy, V. *Text Book of Human Nutrition*; Oxford & IBH Publishing Co. Pvt Ltd. 2009.
5. Lakra, P. and Singh M.D. *Textbook of Nutrition and Health*; First ed; Academic Excellence. 2008.
6. Gibney, M.J. et al. *Public Health Nutrition*; Blackwell Publishing. 2004.
7. Sohi D. A *Comprehensive Textbook of Nutrition & Therapeutic Diets*, New Delhi: Jaypee Brothers Medical Publishers. 2018.

Mapping of Course Outcomes with POs and PSOs

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	3	2
CO-2	3	3	3	2	2	3	3	3	3	2
CO-3	2	3	3	3	3	2	3	3	3	3
CO-4	3	3	3	3	3	3	3	2	2	3
CO-5	2	2	3	3	3	2	3	3	3	3
Ave.	2.6	2.8	3	2.6	2.6	2.6	3	2.8	2.8	2.6

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

SEMESTER I			
Discipline Specific Elective II: Biostatistics			
Course Code: 23PZOE13	**Hrs/Week : 5**	**Hrs/Sem: 75**	**Credits: 3**

Objectives

- To acquire knowledge on the statistical analysis of biological data in day to day life.
- To get an exposure to statistical concepts on the data presentation, analysis, interpretation and significance.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	show the fundamental concepts, gain knowledge and apply on data collection, measures of central tendency, dispersion, estimation, hypothesis, correlation, regression and statistical softwares	K1
CO-2	explain the methods of designing, presentation, analysis, interpretation and application of biostatistics relevant to experimental and population studies	K2
CO-3	apply the acquired skills to perform various statistical analysis using modern statistical techniques and software	K3
CO-4	analyze the knowledge on the merits and limitation of practical problems in biology and implement appropriate statistical methods of analysis	K4
CO-5	evaluate the skill gained in observational and experimental studies with the statistical tools and software in the development of research and employment opportunities	K5

Unit I **Collection and Display of Data** **(15 hrs)**

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 **Measurement of Location and Dispersion** **(15 hrs)**

Measures of central tendency: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error and coefficient of variation.

Unit III **Probability and Probability Distribution** **(15 hrs)**

Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.

Unit IV **Correlation and Regression Analysis** **(15 hrs)**

Hypothesis testing: Student '*t*' test - paired sample and mean difference '*t*' tests. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Significance test for correlation coefficients. Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction.

Unit V **ANOVA and SPSS** **(15 hrs)**

Analysis of variance: one way and two way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS).

Books for Reference

1. Arora, P. N. and P. K. Malhan. *Biostatistics*, Himalaya Publishing House, Mumbai, pp-447. 1996.
2. Gurumani, N. *Introduction to Biostatistics*, M.J.P. Publishers, Delhi, pp-407. 2005.
3. Das, D. and A. Das. *Academic Statistics in Biology and Psychology,* Academic Publisher, Kolkata, pp-363. 2004.
4. Palanichamy, S. and Manoharan, M. *Statistical Methods for Biologists*, Palani Paramount Publications, Tamil Nadu, pp-264. 1990.
5. Bailey, N. T. J. *Statistical Methods in Biology*, English Universities Press, London, pp-48. 1959.
6. Sokal, R. R. and F. J. Rohlf. Introduction to Biostatistics, W.H. Freeman, London, pp-467. 1973.
7. Sokal, R.R. and F.J. Rohlf. *Biometry: The principles and practice of statistics in biological research*. San Francisco: W.H. Freeman, London, pp-859. 1981.

8. Zar, J.H. *Biostatistical Analysis*, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660. 1998.
9. Bailey, N. T. J. *Statistical Methods in Biology (Third Edition)*, Cambridge University Press, Cambridge, pp-255. 1994.
10. Wayne W. Daniel. *Biostatistics: A Foundation for Analysis in the Health Sciences*, John Wiley & Sons Inc, USA, pp-443. 1995.
11. Snedecor, G. W. and W. G. Cochran. *Statistical Methods (Sixth Edition)*, Oxford & IBH Publishing Co., New Delhi, pp-593. 1967.
12. Pagano, M. and K. Gauvreau. *Principles of Biostatistics (Second Edition)*, Cengage Learning, New Delhi, pp-525. 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	**2**	**1**	**2**	**1**	**3**	**3**	**1**	**2**	**2**	**1**
CO-2	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**2**
CO-3	**2**	**3**	**3**	**2**	**3**	**2**	**3**	**3**	**2**	**1**
CO-4	**2**	**1**	**2**	**3**	**3**	**3**	**2**	**2**	**3**	**2**
CO-5	**3**	**2**	**3**	**3**	**2**	**2**	**2**	**3**	**3**	**3**
Ave.	**2.0**	**1.8**	**2.4**	**2.2**	**2.6**	**2.4**	**2.0**	**2.6**	**2.2**	**1.8**

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

SEMESTER I			
Discipline Specific Elective II : Ornamental Fish Culture			
Course Code:23PZOE14	**Hrs/Week:5**	**Hrs/Semester:75**	**Credits:3**

Objectives

- To impart basic understanding for operating an ornamental fish farm and improve the quality of fisheries education, research and extension activities.
- To generate technically skilled manpower to work in ornamental fish farms, augment ornamental fisheries trade, export earnings and self employment.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	CL
CO-1	identify the key concepts of construction, setting up and maintenance of an aquarium and fish health	K1
CO-2	explain the biology, feeding and breeding techniques for commercially important fresh water and marine ornamental fishes	K2
CO-3	apply the skills and competencies in the rearing practices, disease and water quality management and transport of ornamental fishes	K3
CO-4	analyze the various marketing strategies and opportunities in National and International market	K4
CO-5	support their empowerment through harnessing entrepreneurial skill to become an entrepreneur in ornamental fish trade	K5

Unit I **Construction of FishTanks** **(15 Hrs)**

Design and construction of fish tanks – setting up of tanks - accessories for aquarium - hood, light source, hand net, suction tube, scrapper tool, aerator, heater, gravels, filters and aquarium decor –aquarium plants and its importance.

Unit II **Aquarium and Fish Health Management** **(15 Hrs)**

Maintenance of water quality - temperature, water hardness, ammonia, pH, O_2, CO_2. Control of snail and algal growth. Fish diseases - protozoan, fungal, bacterial and parasitic diseases - symptoms, diagnosis, therapy and prevention.

Unit III **Fish Nutrition** **(15 Hrs)**

Different types of feed - artificial and live feed - culture of live feed organisms- infusorians - zooplankton - rotifers - copepods - cladocerans - spirulina - brine shrimp - chironomus - tubifex. Artificial feed: ingredients of feed formulation – Pearson square method of feed formulation - steps in the preparation of artificial feed – nutritional deficiency diseases

Unit IV **Biology and Breeding** **(15 Hrs)**

Taxonomy and biology of egg layers - siamese fighting fish, gold fish, koi, rosy barb, neontetra, zebra cichlid and angel fish. Live bearers - molly, guppy, sword tail and platy. Breeding and spawning of egg layers and livebearers – parental care in ornamental fishes

Unit V **Marine Ornamental Fishes and Transport** **(15 Hrs)**

Commercially important marine ornamental fishes - butterfly fish, parrot fish, clown fish, marine angel fish. Transport of ornamental fishes – oxygen packing use of sedatives - marketing strategies.

Books for Reference

1. Jameson. J.D. and R. Santhanam. *Manual of Ornamental Fishes and FarmingTechnologie*s – Fisheries College and Research Institute TANUVAS, Tuticorin.1996.
2. Santhanakumar. R. and A.M. Selvaraj. *Manual of Freshwater Ornamental Fish Culture*, Department of Fisheries Extension, Fisheries College and Research Institute,TANUVAS, Tuticorin.2007
3. Venkataramani V.K. and N. Jeyakumar. *Biodiversity and Stock Assessment of Marine Ornamental Fishes*. Department of Fisheries Biology and Capture Fisheries Fisheries College and Research Institute, TANUVAS, Tuticorin. 2004.

4. Tharadevi, C.S. and K. V. Jayashree. *Home Aquarium*. Saras Publications, Nagercoil.2009.
5. Santhanam R., Sukumaran N.and P. Natarajan .*A Manual of FreshWater Aquaculture*. Oxford and IBH Publishing Co. Pvt. Ltd, New Delhi.1990.
6. Gupta, S. K. and P. C. Gupta. *General and Applied Ichthyology* 1st Edn. Chand and Company Ltd, New Delhi.2006.
7. Dholakia, A.D.*Ornamental Fish Culture and Aquarium Management*. Daya Publishing House, Tri Nagar, Delhi.2009.
8. Amita Saxena. *Aquarium Management*. Daya Publishing House, Tri Nagar, Delhi. 2003.

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	2	1	1	3	2	1	1	2
CO-2	2	3	2	1	2	2	3	2	2	2
CO-3	2	2	3	2	2	2	2	3	2	2
CO-4	1	1	2	3	2	1	1	2	3	2
CO-5	2	2	2	2	3	2	2	2	2	3
Ave.	2	2	2.2	1.8	2	2	2	2	2	2.2

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

SEMESTER II			
Core III : Cell and Molecular Biology			
Course Code: 23PZOC21	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 5**

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 and molecular biology and 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 physical and chemical signals 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, Diversity of cell size and shapes- 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) lipid bilayer and membrane transport proteins, diffusion, osmosis, ion channels, active transport, ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes.

Unit III Cell Division and Cell Cycle (15 Hrs)

Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. 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 IV Cell Communication and Cell Signaling (15 Hrs)

Signal receptors – Extracellular receptor, Intracellular receptors - signaling through G-protein coupled receptors, signal transduction pathways - signal transduction pathways using second messengers and Lactoferrin. General principles of cell communication - signaling from plasma membrane to nucleus

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 **Course Code :23PZOCR2**

Hours/week :2 **Credits :2**

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 IV: Genetics and Evolution			
Course Code: 23PZOC22	**Hrs/Week: 5**	**Hrs/Sem: 75**	**Credits: 5**

Objectives

- Explore genetic recombination, genetic disorders, evolutionary theories, and the prospective future of human evolution for comprehensive learning.
- 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.NewYork. 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

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: 23PZOCR2** **Credit: 2**

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 GrawHill Book Company, USA. 1977

SEMESTER II			
Discipline Specific Elective III: Economic Entomology			
Course Code: 23PZOE21	**Hrs / week: 4**	**Hrs / Sem: 60**	**Credits: 3**

Objectives

- To enable the students to acquire a fairly good understanding about the life of insects and their classification
- To enable the students to understand the taxonomical study in identification and classification of insects which helps students to get job opportunities as entomologists or in related fields

Course Outcome

CO. No.	Upon completion of this course, students will be able to	Cognitive Level
CO - 1	recall taxonomy, classification and life of insects in the animal kingdom	**K1**
CO - 2	interpret the distributions and abundances of insects, and their interactions with each other and the environment	**K2**
CO - 3	identify beneficial, harmful insects and pests	**K3**
CO - 4	analyze the medical, economic and social impact of insects	**K4**
CO - 5	evaluate the importance of insects in human life	**K5**

Unit I Overview of Insects and Insect Taxonomy (12Hrs)

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

Unit II Beneficial Insects (12Hrs)

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 (12Hrs)

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 – internal (*Sitophilus oryzae*) and external feeders (*Tribolium castaneum*)

Unit IV Pest Management (12Hrs)

Principles and methods of pest control - Natural control, Artificial control, Merits and demerits of these methods in pest control - Development and uses of pest resistant plant varieties - Integrated pest management (IPM) - Concepts and practice.

Unit V Medical Entomology (12Hrs)

Insects in relation to public health – Annoyance, dermatosis, myiasis, envenomization, allergic reaction and entomophobia. 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, pp- 528, 1936.
2. Vasantharaj David, B. and V.V. Ramamurthy. *Elements of Economic Entomology*, Eighth Edition, Brillion Publishing, New York, pp-400, 2016.
3. Ross. H.H. *A Text Book of Entomology*, John Wiley & Sons Inc., New York, pp-746, 1965.
4. Chapman, R.F., S.J. Simpson and A.E.Douglas. *The Insects: Structure and Function*, Fifth Edition, Cambridge University Press, pp-959, 2012.
5. 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.
6. Daly, H.V., J.T. Doyen and P.R. Ehrlich. *Introduction to Insect Biology and Diversity*. Mc Graw-Hill Kogakusha Ltd., Tokyo, pp-564, 1978.
7. Hill, D.S. *Agricultural Insect Pests of the Tropics and their Control*. Cambridge University Press, New York, pp-746, 1974.
8. Krishnaswami, S. *Sericulture Manual*, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome, 1973.
9. Mani, M.S. *General Entomology*. Oxoford & IBH Publishing Co., pp-912, 1982.
10. Wigglesworth, V.B. *The Principles of Insect Physiology*, ELBS & Chapman and Hall, London, pp-827, 1972.

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	3	3	3	3	2	2	2	2
CO-2	3	3	3	2	3	2	3	1	3	1
CO-3	3	2	3	2	2	3	2	2	3	2
CO-4	3	3	2	3	3	3	3	3	3	3
CO-5	2	2	3	2	2	3	2	2	2	3
Ave.	2.8	2.4	2.8	2.4	2.6	2.8	2.4	2	2.6	2.2

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

Elective Practical I **Course Code: 23PZOER1**

Hrs/Week: 2 **Credit: 2**

1. **Mounting:**
    a. Mouth parts of Honey bee
    b. Sting of Honey bee
    c. Pollen basket of Honey bee
    d. Mouth parts of Mosquito
2. Insect collection
3. Observing the life cycle of silkworm
4. Museum specimen: Beneficial insect - Honey bee colony and their product (honey)
5. Museum specimen: Any three insect pests and their damages – one pest on each crop paddy (*Scirpophaga incertulas*), coconut (*Oryctes rhinoceros*), sugarcane (*Chilo sacchariphagus indicus)*.
6. Museum specimen: Life history of the insect vector – House fly
7. Museum specimen: Life history of the insect vector – Mosquito
8. Museum specimen: Any two household insects – bed bug, silverfish
9. Museum specimen: Any two ectoparasites – human head louse, flea
10. Submission of insect box with minimum 10 insects.

Books for Reference:

1. Ayyar, L.V. R. *Hand book of Economic Entomology for South India*. Narendra Publishing House. New Delhi, pp- 528. 1936.
2. Vasantharaj David, B. and V.V. Ramamurthy. *Elements of Economic Entomology*, Eighth Edition, Brillion Publishing, New York, pp-400. 2016.
3. Ross. H.H. *A Text Book of Entomology*, John Wiley & Sons Inc., New York, pp-746. 1965.
4. 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.
5. Hill, D.S. *Agricultural Insect Pests of the Tropics and Their Control*. Cambridge University Press, New York, pp-746. 1974.
6. Krishnaswami, S. *Sericulture Manual*, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome. 1973.

SEMESTER II			
Discipline Specific Elective III: Parasitology			
Course Code: 23PZOE22	**Hrs/Week: 4**	**Hrs/Sem: 60**	**Credits: 3**

Objectives

- To understand the general Parasitology and to impart advanced knowledge on various important protozoan parasites
- To develop a comprehensive knowledge about some important microbial parasites and insects of medical, veterinary and agricultural importance

Course Outcome

CO.No	Upon completion of this course students will be able to	CL
CO – 1	compile the basic biology and life-cycle of parasites including epidemiology, diagnosis and treatment	K1
CO – 2	discuss the morphological characters of parasites and their developmental stages	K2
CO – 3	apply the diagnostic methods of parasitic infestation in real life situations	K3
CO – 4	analyze the mode of transmission through vectors in medical, veterinary and agricultural fields	K4
CO – 5	assess and relate the various causes and protect them from emerging parasitic diseases and handle research activities	K5

Unit I **Introduction to Parasitology** **(15 Hrs)**

Parasitism – Kinds of parasites and hosts - inter relationship between host and parasite - host specificity - Responses of hosts to parasitic infection

Unit II **Parasitic Diseases of man** **(15 Hrs)**

Life cycle, mode of transmission, symptoms, diagnosis and treatment of cholera - *Vibrio cholerae*, Malaria – *Plasmodium*, Amoebiasis - *Entamoeba histolytica* and Dengue – DENV.

Unit III **Parasites from Protozoa, Cestoda, Trematoda and Nematoda (15 Hrs)**

Life cycle, mode of transmission, symptoms, diagnosis and treatment: *Giardia duodenalis – Taenia solium– Fasciola hepatica- Wuchereria bancrofti* - nucleotide probes for diagnosis of parasitic diseases.

Unit IV **Parasitic Adaptations** **(15 Hrs)**

Parasitic mode of life - morphological, biochemical and ethological adaptation - Immune responses of host and self-defense mechanism.

Unit V **Arthropod Vectors of Public Health Importance** **(15 Hrs)**

Vectors - definition, types and control measures. Arthropod vectors of medical, veterinary and agricultural importance – sand flies, mosquitoes, house flies, Reduviid, ticks and mites

Books for Reference

1. Kochhar S.K., *A Text Book of Parasitology*. Dominant Publishers and Distributors –New Delhi, 2009.
2. Veer Singh Rathore and Yogesh Singh Sengar. *Diagnosis Parasitology*. PointerPublishers, Jaipur – India, 2005.
3. Prakash Malhotra, *Applied Parasitology* – Adhyayan Publishers and Distributors -New Delhi, 2008.
4. Jordan E.L. and P.S. Verma. *Invertebrate Zoology*. 14th Edition. Chand and Company Ltd. Ram Nagar, New Delhi, 2009.
5. Ramnik Sood, *Parasitology*, C.B.S. Publisher, New Delhi, 1993.
6. Ramnik Sood, *Text Book of Human Parasitology: Protozoology and Helminthology*, C.B.S. Publisher, New Delhi, 2019.

PSO Relation Matrix – Specimen Table

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	2	3	3	2	2	2
CO-2	3	2	2	1	2	3	2	2	1	2
CO-3	2	3	3	2	3	2	3	3	2	3
CO-4	3	3	2	3	3	3	3	2	3	3
CO-5	3	2	3	3	3	3	2	3	3	3
Ave.	2.8	2.6	2.4	2.2	2.6	2.8	2.6	2.4	2.2	2.6

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

Practicals **Course Code: 23PZOER1**

Hrs/Week: 2 **Credits : 2**

1. Study of parasitic association with their example - a) Commensalism. b) Parasitism.

2. Study of the life cycle, pathogenecity, diagnosis and treatment of *Entamoeba histolytica* and *Plasmodium vivax* through permanent slides or microphotographs.

3. Study of the life cycle, pathogenecity, diagnosis and treatment of *Ascaris lumbricoides* and *Taenia solium* through specimen, permanent slides or microphotographs.

4. Study of following parasites with its role as vector - Soft tick, *Pediculus humanus* and *Cimexlectularius* through permanent slides or photographs

5. Study of adult and life stages of *Ascaris lumbricoides, Ancylostoma duodenale* and *Wuchereria bancrofti* through permanent slides/micro photographs.

6. Observation and identification of different stages of parasites and parasitic diseases

7. Preparation of media for bacteria, protozoa and helminthes culture

8. Study on different zoonotic disease – Anthrax, Rabies, Trichinosis

9. Collection and submission of various parasites

10. Field survey report (general survey and status of medical veterinary and agricultural importance parasites and parasitic diseases).

Books for Reference

1. Philip Alba Hawkins, *Introduction to Parasitology : A Laboratory Manual* Burgess Publishing Company, 1956.
2. Halton D. W., I. Marshall and J. M. Behnke, *Practical Exercises in Parasitology*, Cambridge University Press

SEMESTER II			
Discipline Specific Elective IV: Research Methodology			
Course Code: 23PZOE23	**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, absorption and emission 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 – ultra centrifuge – 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.

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**

Practicals **Course Code: 23PZOER1**

Hrs/ Week: 2 **Credits: 2**

1. Fractionation of fish liver by density gradient centrifugation
2. Measurement of cell size by micrometry
3. Phase contrast microscopic observation of living cells
4. Estimation of protein by Lowry method
5. Absorption spectra of proteins
6. Column chromatographic separation of plant pigments
7. Checking plagiarism by turnitin (online demo)
8. Preparation of research report
9. Use of different instruments in research methodology (Spotters)
    a. Electron microscope
    b. Chromatography – HPLC
    c. SDS-PAGE

Books for Reference

1. Gurumani. R*esearch Methodology for Biological Sciences*. Chennai: M.J.P. Publishers. 2011.
2. Veerakumari. L. *Bioinstrumentation.* Chennai: M.J.P. Publishers. 2007.

SEMESTER II			
Discipline Specific Elective IV: Nanotechnology			
Course Code: 23PZOE24	**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.

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

Practicals **Course Code: 23PZOER1**

Hrs/ Week: 2 **Credits: 2**

1. Synthesis of Ag metal nanoparticles by chemical route

2. Biogenic synthesis of nanoparticles using animal extract

3. Synthesis of Nickel metal nanoparticle by urea decomposition method

4. Synthesis of Zinc oxide nanoparticles

5. Synthesis of Iron Oxide nanoparticles

6. Synthesis of copper nanoparticles

7. Isolation of enzymes involved in biosynthesis of nanopartices

8. Synthesis of gold nanoparticles using shell extract

9. Chart – Structure of Fullerene, Nanobiosensor

Books for Reference

1. Subbiah Balaji. *Nanobiotechnology,* MJP Publishers, Chennai. 2010.
2. Gerrard Eddy Jai Poinern. *A Laboratory Course in Nanoscience and Nanotechnology*, CRC Press, USA. 2014.

SEMESTER II			
Skill Enhancement Course I Poultry Farming			
Course Code: 23PZOSE1	**Hrs/Week : 4**	**Hrs/Sem: 60**	**Credits: 2**

Objectives

- To impart knowledge on the fundamentals of poultry management and advanced technology in 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
CO-1	demonstrate the present status of poultry industry in India and various practices in poultry farming	K1
CO-2	plan and utilize the advanced farming practices to manage it in a profitable manner	K2
CO-3	apply innovative technologies to manage the problems encountered in poultry keeping	K3
CO-4	analyse the management techniques to handle various situations in poultry farming	K4
CO-5	evaluate the strategies to get a rewarding carreer 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 ofpoultry 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, gritfeeding. Poultry products for good nutrition – 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)**

Nutritional requirements-energy-proteins and amino acids – vitamins and essential inorganic elements, feed stuffs of poultry, feed formulation– non nutritive feed additives.

Unit V **Disease Management** **(12 Hrs)**

Poultry diseases -viral-Ranikhet, Fowl pox, bacterial –Salmonelloses, Foul Cholera, fungal – Aspergillosis, Aflatoxicosis and parasitic diseases-Coccidiosis, external parasites – tick and mite, vaccination programme, homeopathy in poultry diseases.

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*. Giri Publication, Madurai. 2003.
3. Ensminger, M.R. *Poultry Science* CBS Publishers & Distributors Pvt.Ltd. New Delhi. 2015.
4. Ravindranathan. *A Text Book of Economic Zoology*. Wisdom Press, New Delhi.2013.
5. Prakash Malhotra. *Economic Zoology*. Adhyayan publishers, New Delhi.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	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 III			
Core V: Animal Physiology			
Course Code: 23PZOC31	**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 Systems** **(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 - reflex arc. Muscular system: Mechanism of muscle contraction - sliding filament theory. Sensory system: physiology of vision, hearing and equilibrium 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, 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: 23PZOCR3** **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 III			
Core VI: Immunology			
Course Code: 23PZOC32	**Hrs / Week : 5**	**Hrs / Sem: 75**	**Credits : 5**

Objectives:

- To understand the fundamentals of immunology and key principles of immune system.
- To impart knowledge on the structure and functioning of immune system and how it relates to health and disease.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	C L
CO-1	recall immunoglobulin genetics, including gene rearrangements, the dynamics of antigen-antibody reactions and address immunological disorders within clinical scenarios.	K1
CO-2	explain immunological concepts, techniques, and disorders tailored for industrial applications, while actively engaging in lifelong learning practices to ensure adaptability across diverse environments.	K2
CO-3	apply skills in diagnosing complex immunological disorders to make substantial contributions to both research and clinical practice, while also innovating solutions to address emerging challenges within the field.	K3
CO-4	analyze gene expressions, immunological reactions, defects, and immunotherapeutics to deepen comprehension of immunological mechanisms and their broader implications across diverse disciplines.	K4
CO- 5	evaluate the clinical implications of various immunological disorders in clinical scenarios to address societal needs	K5

Unit I **Organisation and Expression of Immunoglobulin Genes** **(15 hrs)**

Scope - structure of Immunoglobulin (IgG) - Genetic model for Immunoglobulin structure - germ line and somatic variation – Dryer and Bennett two gene model organization of Immunoglobulin (Ig) genes. Gene rearrangements in variable region - mechanism of variable region DNA rearrangements - generation of diversity – class switching.

Unit II **Antigen - Antibody Responses** **(15 hrs)**

Antigen - Antibody reactions: Salient features of antigen antibody reaction. Detection of antigen antibody reaction - precipitation - single radial immunodiffusion – double immunodiffusion – immunoelectrophoresis – rocket immuno electrophoresis - immunofluorescence. Agglutination: haemagglutination - bacterial agglutination- passive agglutination - agglutination inhibition test - ELISA.

Unit III **Immunobiology** **(15hrs)**

Hypersensitivity: Types – Type I Anaphylaxis – Type II Antibody dependent cytotoxicity – Type III Immune complex mediated disease – Type IV Delayed type hypersensitivity and Type V Stimulatory hypersensitivity - factors causing hypersensitivity - Major Histocompatibility Complex - MHC molecules – structure, distribution and functions - clinical importance of HLA - HLA typing - HLA paternity testing - HLA and diseases.

Unit IV **Diseases and Immune Responses** **(15 hrs)**

Immunodeficiency diseases- Humoral deficiencies- X linked Agammaglobulinemia and X linked hyper IgM syndrome, Cell mediated deficiencies- Di George syndrome,Combined immunodeficiencies- Bare-lymphocyte syndrome, Severe Combined Immunodeficiency -Adenosine Deaminase and Purine Nucleoside Phosphorylase deficiency. Autoimmunity – causes of autoimmune diseases – spectrum of diseases and major immune responses – diagnosis and treatment.

Unit V **Clinical Immunology** **(15 hrs)**

Tumour immunology – tumour antigens - natural immunity to tumours – T cell mediated immunity to tumours - therapeutic approaches to cancer - immune surveillance. Transplantation immunology - types of grafts - mechanism of graft rejection - graft versus host reaction – immune suppression - prevention of graft rejection. Vaccine – types – live attenuated vaccine and inactivated killed vaccines – Vaccination schedule.

Books for Reference

1. Catherine Sheehan. *Clinical Immunology. Principles and Laboratory Diagnosis*. Philadelphia: Wolterskluwer Company1997.
2. David Male, Brian Champian and Annie Cooke. *Advanced Immunology*. Philadelphia: J.B. Lippincott Company, Gower Medical Publishing 1987,
3. Emil R. Unanue and Baruj Benacerraf. *Text Book of Immunology. II Edition.* London: Williams and Wilkins 1984.
4. Ivan M. Roitt. *Essential Immunology*. Oxford: Blackwell Scientific Publications 1994.
5. Joshi K.R and Osamo N.O. *Immunology*. India: Agro Botanical Publishers 1994.
6. Mary S. Leftfel, Albert D. Donnenberg and Noel R. Rose. *Hand Book of Human Immunology*. New York: CPC Press 1997.
7. Vamen Rao C. *Immunology*. New Delhi: Narosa Publishing House 2011.
8. Rastogi, S.C. *Essentials of Immunology*. New Delhi: CBS Publishers and Distributors 2002.
9. Talwar G.P. and Gupta S.K. *A Hand Book of Practical and Clinical Immunology.* Delhi: CBS Publishers and Distributors 1993.
10. Yadav P.R. *Immunology.* New Delhi: Discovery Publishing House 2004.
11. Surendra Naha. *Fundamentals of Immunology*. New Delhi: Dominant Publishers Pvt. Ltd 2012.
12. Sudha Gangal and Shubhangi Sontakke. *Textbook of Basic and Clinical Immunology*. Hyderabad: Universities Press (India) Pvt. Ltd 2016.

Web Resources

1. https://www.aaaai.org/
2. https://www.bsaci.org/
3. https://www.immunology.org/
4. https://nptel.ac.in/courses/102/103/102103038/
5. https://microbenotes.com/category/immunology/

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	1	2	3	2	2	3	2
CO-2	3	3	1	2	2	3	3	2	3	2
CO-3	3	3	3	3	2	3	3	3	2	2
CO-4	3	3	3	3	2	3	3	3	3	2
CO-5	3	3	2	1	2	3	2	2	2	3
Ave.	3.0	3.0	2.0	2,0	2.0	3.0	2.6	2.4	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: 23PZOCR4** **Credit - 1**

1. Radial Immunodiffusion
2. Double Immunodiffusion.
3. Anti irritant activity in chick embryo
4. Direct Agglutination - ABO blood grouping.
5. Rh - Typing.
6. Rocket Immuno electrophoresis.
7. ELISA - Demonstration.
8. Isolation of lymphocytes and enumeration.
9. HLA typing.
10. Lymphoid organs in rat (spotter)

Books for Reference

1. Rabindra Narain, *Practical Immunology*. New Delhi: Wisdom Press, 2012.
2. Talwar G and S. K. Gupta. *A Handbook of Practical and Clinical Immunology*.Vol. 1 Second Edition. Delhi: CBS Publishers & Distributers 1992.

SEMESTER II			
Core VII	**Microbiology**		
Course Code: 23PZOC33	**Hrs/ Week : 5**	**Hrs / Sem : 75**	**Credits : 5**

Objective

- To impart knowledge on taxonomy, structural organization and impact of microbes in the organisms.
- To develop core competencies in the field of microbiology and inculcate scientific thinking

Course Outcome :

Co.No	Upon completion of this course, students will be able to	CL
CO-1	describe the different types of microorganisms, structural organization and life cycle to pursue higher learning opportunities	K1
CO-2	compare microorganisms based on microbial and systematic taxonomy to become skilled professional in the field	K2
CO-3	compile the symptoms, causative agent, treatment and prevention of infectious diseases to solve biological problems	K3
CO-4	analyze the role of microorganisms in fermentation, formulation of microbial products and compete in the job market	K4
CO-5	evaluate the basic concepts underlying diverse areas such as medical, industrial, environment, food, and agricultural industry.	K5

Unit I Classification (15Hrs)

Classification of microorganism – Five Kingdom system, Eight kingdom system Three domain concept. Modern trends of bacterial taxonomy - ribosomal RNA and sequencing - construction of phylogenetic tree. General features of groups of microorganisms. -Rickettsias, Chlamydias, Mycoplasmas, Algae, Archaeobacteria, Actinomycetes and fungi.

Unit II Cultivation of Microorganisms (15Hrs)

Preparation of culture media – types of media- isolation and maintenance of pure culture - cultural and morphological characteristics of bacteria, fungi – microscopic examination of microorganisms - Gram staining - acid fast staining – spore staining - capsular staining – flagellar staining. Analysis based on Bergey's Manual of Determinative Bacteriology (biochemical tests).

Unit III Structural Organization of Microbes (15Hrs)

Structural organization of bacteria – structure of *E. coli*, virus – plant virus – Tobacco Mosaic Virus, animal virus – adenovirus - bacteriophage and fungi – yeast, penicillium - life cycle of Actinomycetes and yeast.

Unit IV Production of Microbial Products (15Hrs)

Yeast fermentation and its products – production of ethyl and methyl alcohol, beer and wine. Mixedfermentation product - production of vinegar. Production of antibiotics – streptomycin, and tetracycline. Dairy product - yoghurt, kefir

Unit V Microbial Diseases (15Hrs)

Microbial Diseases – Causative organisms, symptoms, mode of transmission and prevention of protozoan diseases - amoebiasis and leishmaniasis. Bacterial diseases- diphtheria, tetanus and gonorrhea. Viral diseases - corona virus, dengue fever and rabies. Fungal diseases - actinomycosis, aspergillosis, ringworm and candidiasis

Books for Reference

1. Arti Kapil. *Text Book of Microbiology*. Hyderabad: University Press 9th Edition. 2016
2. Dubey R .C and D.K. Maheswari. *A Text Book of Microbiology.* New Delhi: S. Chand & Co. 2006
3. Roger Stainer, John Lingraham, Mark I Wheelis and Page R. Painter. *General Microbiology.* London: Mac Millan, Hampshire 1992.

4. Pelzer Chan and Krieg. *Microbiology*. New Delhi: Tata Mc Grow Hill Publishing Company, 2nd Edition 1998.
5. Wulf Crueger and Annellese Crueger. *Biotechnology*: *A Textbook of Industrial Microbiology*. New Delhi: CBS Publishers and Distributors, 3rd Edition. 2016.
6. Presscott Harley and Klein. *Microbiology*. New York: WCB Mc Graw Hill Co. 2005
7. Purohit S.S. *Microbiology – Fundamentals and Application*. India: M/S Saraswathi Publication, 1991
8. Power C.B and K.F. Daginawala. *General Microbiology*. Vol I & II. Himalaya Publishing House, 1988.
9. Ramesh. *Food Microbiology*. Chennai: MJP Publishers. 2007
10. Casida, J.R. *Industrial Microbiology*. New Delhi: New Age International Pvt. Ltd., 2nd Edition 2015
11. Ananthanaryanan, R and J. Panikar. *Text Book of Microbiology*, Chennai Anna Salai :Orient Longman Private Ltd., 160, 7th Edition. 2006.
12. Robert I.Krasner: *The Microbial Challenges Science, Disease and Public Health* second Edition. Jones and Bartlett Publishers.2010.

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	1	3	2	3	2	1
CO-2	3	2	3	1	2	3	3	3	2	2
CO-3	2	3	3	3	2	3	2	3	3	2
CO-4	2	3	2	3	3	1	2	1	2	3
CO-5	2	2	3	3	3	2	3	1	3	3
Ave.	2.4	2.6	2.8	2.4	2.2	2.4	2.4	2.2	2.4	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 23PZOCR4** **Credit: 1**

1. Sterilization Techniques
2. Aseptic handling for microbial studies - Demo
3. Preparation of culture media

   Nutrient broth, Nutrient agar, Potato dextrose agar, Mueller- Hinton agar
4. Counting of viable cells (CFU/ ml) by serial dilution & spread plate or pour plate methods
5. Pure culture techniques - Streaking and spread plate methods.
6. Gram Staining & Spore staining
7. Simple biochemical tests of bacteria
   a. Acid and gas production in glucose broth
   b. Starch hydrolysis
   c. Catalase
   d. Nitrate reduction
8. Dye reduction test of milk
9. Test for antibiotic sensitivity - Kirby Bauer disc diffusion test
10. Isolation of symbiotic nitrogen fixing bacteria from root nodules
11. Observation of algae and fungi

    Algae – Nitzschia, Chlorella

    Blue Green Algae – Spirullina

    Fungi - Aspergillus

Books for Reference:

1. Kannan N. *Laboratory Manual in General Microbiology* Palani: Palani Paramount Publications, 1996.
2. James Cappuccino and Natalie Sherman. *Microbiology: A Laboratory Manual 10th Edition.* Published by Pearson India Education Services Pvt.Ltd. 2014.
3. Dubey R.C. and D.K. Maheswari. *Practical Microbiology*. New Delhi: S Chand &Company Ltd. 2008.

SEMESTER – III			
Discipline Specific Elective V : Applied Biotechnology			
Course Code : 23PZOE31	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 3**

Objectives:

- To motivate the students to develop scientific attitudes towards emerging technologies
- To discover the potential sources of biotechnology and their applications in various fields

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	recall the biotechnological methodologies that can be applied in various fields	K1
CO-2	relate the knowledge gained to empower themselves with entrepreneurial skills	K2
CO-3	apply their skills to address the challenges faced by human population	K3
CO-4	examine the possibility of applying biotechnology to various fields and efficiently cater to human needs	K4
CO-5	select an appropriate field of biotechnology to empower themselves with an entrepreneurial venture	K5

Unit I Microbial Biotechnology (12 hours)

Isolation and improvement of microbial strains –microbial production of food (yoghurt, bread) –beverages (wine, beer) – microbial production of antibiotics (penicillin) - microbial production of organic acids (citric acid) - microbial production of vitamins (riboflavin)- microbial production of organic solvents (ethanol).

Unit II Medical Biotechnology (12 hours)

Gene therapy approaches : Ex vivo- gene therapy for adenosine deaminase deficiency, in vivo gene therapy - cancer and AIDS. Pharmaceutical products: Insulin, human growth hormone. Recombinant vaccines: Hepatitis B, Tuberculosis. Monoclonal antibodies-production and applications.

Unit III Environmental Biotechnology (12 hours)

Biological waste management – sewage treatment- (Primary, Secondary and Tertiary treatment). Biodegradation and Bioremediation – Recalcitrant Xenobiotics, Types of Bioremediation (*in situ, ex situ*), Bioremediation of Hydrocarbons , Bioremediation of pesticides and herbicides. Genetic Engineering for bioremediation - superbug

Unit IV Genetic Engineering (12 hours)

Construction of animal viral vectors for animal transformations-methods of developing transgenic animals: (sheep, pig, poultry) –genetically engineered microbes (GEMOs)-applications of genetic engineering- ethical implications and the risks of releasing genetically engineered organisms.

Unit V Nanobiotechnology (12 hours)

Introduction to nanotechnology – Green synthesis, Characterization and Applications of nanparticles, Drug delivery systems – Prostheses and Implants – Diagnosis and Screening – DNA Microarray, Protein Microarray – Gene chip - Nanobiosensor, Nanomedicine.

Books for Reference

1. Dubey R.C. *A Text Book of Biotechnology*, 4th edition. , New Delhi: S. Chand& Company Ltd. 2006.
2. Singh B.D. *Biotechnology*. Revised edition. New Delhi: Kalyani Publishers. 2005.
3. Kumaresan V. *Biotechnology*. Nagerkoil: Saras Publication. 2009.
4. RemaL.P. *Applied Biotechnology*. Chennai: MJP Publishers, 2007.
5. Satyanarayana U. *Biotechnology*. Kolkatta: Books and Allied (P) Ltd. 2006.
6. Robert Preidt, Laura Costlow and Peter *Introductory Nanotechnology*. New Delhi: Dominant Publishers and Distributors. 2007.
7. Suhas Bhattacharya. *Introduction to Nanotechnology*. New Delhi:Wisdom Press. 2013.
8. Subbiah Balaji , *Nanobiotechnology*. Chennai: MJP Publishers, 2010.

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	2	2	3	3	2	2	2	3
CO-2	2	2	2	2	3	2	2	2	2	3
CO-3	2	2	2	2	2	2	2	2	2	2
CO-4	2	3	2	2	2	2	3	2	2	2
CO-5	3	3	3	2	3	3	3	3	2	3
Ave.	2.4	2.4	2.2	2.0	2.6	2.4	2.4	2.2	2.0	2.6

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

SEMESTER – III			
Discipline Specific Elective V : Animal Behaviour			
Course Code : 23PZOE32	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 3**

Objectives:

- To acquire comprehensive knowledge on the fundamental concepts of animal behaviour
- To understand the biological rhythms that control animal behaviour

Course Outcome

CO.No	**Upon completion of this course, students will be able to**	**CL**
CO-1	identify the various behavioural patterns of animals in relation with genes and environment	K1
CO-2	extend the knowledge on behavioural patterns of animals to empower her skills on pet care	K2
CO-3	apply the knowledge gained to enhance animal well being	K3
CO-4	analyze and establish businesses that focus on training and behaviour modifications	K4
CO-5	Recommend an appropriate entrepreneurial venture in animal husbandry, pet care, poultry, dairy, apiculture, sericulture etc.	K5

Unit I **Introduction to Animal Behaviour** **(12hours)**

Origin and history of ethology- Types of behaviour - Innate behaviour, learning, reasoning, motivation - Migration and homing with special reference to birds- Communication in animals: Visual, olfactory, auditory and tactile. Camouflage and mimicry- types of mimicry

Unit II **Ecological and Social Aspects of Behaviour** **(12hours)**

Habitat selection- food selection and optimal foraging theory- anti-predator defense mechanism- aggression, territoriality and dispersal. Schooling in fishes, flocking in birds, herding in mammals, group selection, kin selection , altruism, inclusive fitness and social organization in insects and primates

Unit III **Reproductive Behaviour** **(12hours)**

Evolution of sex, reproductive strategies, mating systems, courtship, sperm competition, sexual selection and parental care. Hormones and behaviour- Pheromones and behaviour.

Unit IV **Biological Rhythms** **(12hours)**

Circadian, Circannual, tidal/lunar, ultradian, infradian rhythms-Synchronization of biological rhythms, phase shift - Photoperiodism with reference to birds and mammals-Human Circadian rhythms.

Unit V **Genetic Basis and Evolution of Behaviour** **(12hours)**

Role of genes in shaping the behaviour of an animal – Single gene effects- mendelian crosses, Mutations, Knockout genes, Genetic Mosaics – Multiple gene effect – Microevolution and Macroevolutionary changes of Behaviour – Behaviour and Speciation.

Books for Reference

1. Dustin R.Rubenstein, Johb Alcock. 2019. *Animal Behaviour.* Oxford University Press, New York
2. Agarwal VK. *Behaviour (Ethology)* 2020. S Chand and Company Limited, India.
3. Mandal Fatik Barar, 2015. *Textbook of Animal Behaviour*. India: PHI Learning Pvt Ltd; 3rd Edition.
4. Shukla J.P, 2021. *Fundamentals of Animal Behaviour.* India: Atlantic, First Edition.
5. Reena Mathur, 2018. *Concepts of Animal Behaviour* (*Z-80*). India: Rastogi Publications; 1st Edition.

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	2	2	2	3	2	2	2	2
CO-2	3	2	2	2	2	3	2	2	2	2
CO-3	2	2	2	2	2	2	2	2	2	2
CO-4	2	2	2	3	3	2	2	2	3	3
CO-5	2	2	3	3	3	2	2	3	3	3
Ave.	2.4	2.0	2.2	2.0	2.4	2.4	2.0	2.2	2.0	2.4

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

SEMESTER III			
Skill Enhancement Course II : Dairy Farming			
Course Code: 23PZOSE2	**Hrs/Week : 4**	**Hrs/Sem: 60**	**Credits: 3**

Objectives

- To understand the general management of dairy animals and various techniques of dairy farming.
- To obtain knowledge on different breeds, nutritional requirements and various diseases of cattle.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	describe the various management techniques in dairy farming and develop skills to identify the breeds	K1
CO-2	explain the dairy house, feeding management, needs for dairy farming and the status of dairy in current scenario	K2
CO-3	compile the basic concepts and management approaches of dairy farming to find innovative solutions in the research	K3
CO-4	appraise the skill and knowledge obtained from dairy farming to become an entrepreneur	K4
CO-5	evaluate the difficulties in dairy farming and propose plans for the scientific development of society	K5

Unit I Introduction to Dairy Farming

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.

Unit II Dairy House and Management

Construction of Model Dairy House – Major components of a housing system - Types of Housing - Different Managemental Parameters - Winter Management - Summer Management.

Unit III Feeding and Health Care

Feed stuffs – hay – silage - pastures - Mineral Supplements - Vitamin Supplements - Feed additives - Feeding management - Calves Feeding - Feeding of adults - Feeding of pregnant dairy animals - Feeding pregnant heifer.

Unit IV Composition and Nutritive Value of Milk

Milk - Composition of milk – milk products – butter – cheese - Role of milk and milk products in human nutrition - milk spoilage – pasteurization – Quality and testing of milk parameters – physical (colour, flavor, viscosity, boiling point, heat stability of milk) and chemical characteristics (fat, protein, carbohydrate) – adulteration – with water and preservatives (urea, starch, caustic soda and salicyclic acid).

Unit V Diseases and Economics of Dairy Farming

Common Bacterial diseases – Anthrax, joint ill, mastitis - Helminth – Worm infestation and Viral Diseases – Calf scours - blue tongue - Parasitic and Protozoan diseases – Theilariasis, Babeisiosis, Trypanosomiasis, Trichomoniasis - Vaccination. Dairying as a source of additional income and employment.

Books for Reference

1. Roger W. Blowey. *The Veterinary Books for Dairy Farmers*. Old Pond Publishing Ltd., 2016.
2. Board Eiri. *Hand Book of Dairy Farming*. Engineers India Research Institute, 2008.
3. Aruna T. Kumar. *Handbook of Animal Husbandry*. TATA, S.N ed., ICAR, 1990.
4. Prabakaran R. *Commercial Chicken Production*. Saranya, Students' Offset center, Chennai, 1998.
5. Hafez E. S. E. and B. Hafez. *Reproduction in Farm Animals*. Wiley-Blackwell, 2000.

6. Shyam Kishore Singh. *Dairy Farming.* Alfa Publications, New Delhi, 2012.
7. Schmidt G.H. and L. D. Van Vleck. *Principles of Dairy Science*. Surjeet Publications, Delhi. 1982.

Web Resources:

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

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	2	3	2	3	1
CO-2	1	3	2	3	1	1	2	3	2	2
CO-3	2	2	3	2	3	2	3	3	2	1
CO-4	2	3	1	2	3	3	3	2	2	3
CO-5	2	2	3	1	3	1	2	3	2	3
Ave.	2	2.4	2	2	2.2	1.8	2.6	2.6	2.2	2

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

SEMESTER III	
Self Study: Zoology for Competitive Examination	
Course Code: 23PZOSS1	**Credits: +2**

Objectives

- To motivate the students and make them to compete in the competitive examinations effectively.
- To impart in-depth knowledge on different domains of Zoology to promote the competitive skills for various examination.

Course Outcome

CO. No.	Upon completion of this course, students will be able to	CL
CO-1	describe the different forms of life, organization and gain knowledge on biomolecules and relate the various physiological mechanisms of organisms	K1
CO-2	summarize the concepts, different theories, patterns, significance and pathogenicity in the living organisms towards lifelong learning	K2
CO-3	demonstrate various techniques in the field of biology and biotechnology to resolve complex problems to find novel solutions in research and higher education	K3
CO-4	analyze the knowledge and skills acquired through various fields of zoology and its application in the environment	K4
CO-5	evaluate the different dimensions and perspectives in the biology for holistic personality development and empowerment	K5

Unit I **Diversity of Life Forms**

Concepts of species and hierarchial taxa, biological nomenclature, classical and quantitative methods of taxonomy of animals. Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Classification of invertebrates up to classes and chordates up to order – diagnostic

features and examples. Organisms of conservation concern – principles of conservation - rare, endangered species - conservation strategies.

Unit II Biochemistry and Physiology

Composition, structure and function of biomolecules - carbohydrates, lipids, proteins, nucleic acids and vitamins. Conformation of proteins - Ramachandran plot. Physiology of digestion and absorption, respiration, transport of oxygen, carbon-di-oxide; structure of kidney and nephron, urine formation in man; structure of heart, cardiac cycle; structure, composition and functions of blood of man; types of muscle, structure of neuron, nerve impulse conduction, physiology of vision and hearing in man. Structure and functions of pituitary, Islets of Langerhans and thyroid gland. Human reproductive systems – menstrual cycle.

Unit III Genetics and Evolution

Mendelian principles, modern concept of gene, split gene, genetic regulation, genetic code. Sex chromosomes and their evolution, sex determination in Drosophila and man. Recombination, linkage, multiple alleles, genetics of blood groups, pedigree analysis, hereditary diseases in man – Inborn errors of metabolism- mutations and mutagenesis, structural and numerical alterations of chromosomes. Theories of evolution- natural selection, role of mutation in evolution, evolutionary patterns, molecular drive, mimicry, variation, isolation and speciation, biological and cultural evolution of man.

Unit IV Cell and Molecular Biology

Structure of model membrane, Structure and function of cell and its organelles (nucleus, plasma membrane, mitochondria, Golgi bodies, endoplasmic reticulum, ribosomes and lysosomes), cell division and cell cycle (mitosis and meiosis), steps, control and regulation of cell cycle, chromosome movement, chromosome type – polytene and lamp brush, organization of chromatin, heterochromatin. Protein synthesis, structure of DNA, RNA, replication of DNA. Nucleic acid topology, DNA motif, transcription, RNA processing, translation, protein folding and transport.

Unit V Biotechnology and Microbiology

DNA sequencing methods, RFLP, RAPD and AFLP techniques, transgenic animals. Bioremediation and phytoremediation. Biosensors, tissue culture, Genomics and its applications to health – gene therapy – recombinant vaccines. Major infectious and communicable diseases (malaria, filariasis, tuberculosis, cholera, AIDS and Covid-19) their vectors, pathogens and prevention.

Books for Reference

1. Jordan. K.C. & Verma. P.S. *Invertebrate Zoology*. New Delhi: S. Chand & Company Ltd. 2009.
2. Jordan E.L. and Verma. P.S. *Chordate Zoology*. New Delhi: S. Chand & Company Ltd, Ram Nagar. 1965.
3. Sinha, Adhikari, Ganguly, Bharati Gowswani. Biology of Animals – Volume I. Kolkata: New Central Book Agency; 7th edition. 2012.
4. Sinha, Adhikari, Ganguly, Bharati Gowswani. Biology of Animals – Volume II. Kolkata: New Central Book Agency; 7th edition. 2012.
5. Ambika Shanmugam. *Fundamentals of Biochemistry for Medical Students*. Madras: Navabharat Printers and Traders. 2012.
6. Satyanarayana. U and U. Chakrapani. *Biochemistry*. Haryana and Kolkata: Elsevier and Allied. Fourth Edition 2014.
7. Shembulingam. K. and Prema Shembulingam. *Essentials of Medical Physiology*. New Delhi : Jaypee Brothers, Medical Publishers Ltd. 2005.
8. Verma. P.S and Agarwal. V.K. *Cell Biology, Genetics, Molecular Biology, Evolution & Ecology*. New Delhi: S. Chand & Company Ltd, Ram Nagar. 2013.
9. Kumaresan. V. *Biotechnology*. Nagercoil: Saras Publication. 2009.
10. Presscott Harley and Klein. *Microbiology*. New York: WCB Mc Graw Hill Co. 2005.

Web Resources:

1. https://byjusexamprep.com/csir-net/csir-net-life-science-study-notes-material#toc-13
2. https://unacademy.com/content/csir-ugc/study-material/life-sciences/
3. https://www.shomusbiology.com/csir-net-life-science-books-free-download-pdf.html

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	2	3	1	3	2	2	3	1
CO-2	1	3	3	2	2	1	3	2	3	2
CO-3	2	1	3	3	2	2	3	3	1	2
CO-4	3	3	1	3	2	3	2	2	3	2
CO-5	2	3	2	2	3	2	1	1	3	3
Ave.	2.2	2.4	2.2	2.6	2	2.2	2.2	2	2.6	2

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

SEMESTER IV			
Core VIII: Marine Biotechnology			
Course Code: 23PZOC41	**Hrs/Week : 5**	**Hrs/Sem: 75**	**Credits: 5**

Objectives

- To impart knowledge of biotechnological applications of marine organisms among the students.
- To provide an excellent education emphasizing the important processes and impacts on the marine ecosystems and ways to control them.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	recall the different ecological zones of marine environment and gain knowledge on the resources to develop core skills	K1
CO-2	explain the marine ecosystem and to combat its pollution through various biological approaches and analytical skills	K2
CO-3	compile the types of marine resources and assess the various environmental concerns to cater the need of higher learning opportunities	K3
CO-4	examine the complexity, diversity of resources in the marine environment and gain knowledge on its conservation strategies	K4
CO-5	evaluate and design effective solutions to problems in the marine environment for scientific progress in the society	K5

Unit I **Marine Habitat** **(15 hrs)**

Classification of marine habitat - Intertidal rocky, sandy and muddy shores – the features of fauna and adaptations. Plankton – classification and adaptations. Primary production in ocean.

Unit II **Marine Ecosystems** **(15 hrs)**

Estuaries, mangroves, coral reef – ecology and types, species interaction and adaptations. Conservation of Gulf of Mannar Biosphere Reserve. Role of microbes in recycling of nutrients – nitrate, phosphate and sulphate.

Unit III Marine Pollution (15 hrs)

Sources, effects and control measures of heavy metal, radioactive, oil and thermal pollutions. Biotechnology in marine pollution control. Marine bioremediation in microbes - microplastics.

Unit IV Microbial Action in the Marine Environment (15 hrs)

Biofouling – biofoulers – micro and macro foulers – impact of biofouling in maine environment and prevention. Biodeterioration: agents and protective methods. Corrosion – mechanism and prevention.

Unit V Wealth of the Sea (15 hrs)

Mineral wealth – petroleum, manganese nodules, beach placers, glauconite and garnet. Extraction of bioactive compounds – sample preparation and extraction. Bioactive compounds from marine organisms (bacteria, fungi micro, macro algae and sponges). Sea-ranching of economically important marine organisms – crustaceans and molluscs.

Books for Reference

1. Bimla Singh. *Marine Biotechnology and Aquaculture Development*. Delhi: Vista International Publishing House. 2006.
2. Girish Chopra. *Coastal and Marine Geography*. Delhi: Common Wealth Publisher. 2012.
3. Gross G. *Oceanography: A View of the Earth*. New Jersey: Sixth edition. Prentice Hall Inc. 2008.
4. Mc Cormick J.M. and J.V. Thiruvathaakal. *Elements of Oceanography*. Philadelphia: W.B. Saunders Company. 1981.
5. Nybakken J.W. *Marine Biology – An Ecological Approach*. California: Addison Weslay Longman, Inc. 1997.
6. Olivia J. Fernando. *Sea water-Properties and Dynamics*. Thanjavur: Dhanesh Publications. 1999.
7. Frank E. Firth. *The Encyclopedia of Marine Resources*. New York: Van Nostrand Reinhold Company.1969.
8. Veena. *Understanding Marine Biology*. New Delhi: Discovery Publishing House Pvt. Ltd. 2012.
9. Atlas R.M. and Bartha. M. *Microbial Ecology- Fundamentals and Applications*. California:

Benjamin- Cummings. 2003.

10. Vijaya Ramesh K. *Environmental Microbiology*. Chennai: MJP Publishers. 2004.
11. Moshrafuddin Ahamed and Basumatary S.K. *Applied Microbiology*. Chennai : MJP Publishers. 2006.
12. Tait R.V. and F.A. Dipper. *Elements of Marine Ecology*. Great Britain: British Library Cataloguing in Publication Data. 4th edition 1998.
13. Frances Dipper, *Elements of Marine Ecology*. Elsevier Butterworth-Heinemann Ltd., Fifth Edition. 2022.
14. Seshappa G, *Indian Marine Biology*. Daya Publishing House, Astral International Pvt. Ltd., New Delhi. 2018.

Web Resources:

1. https://study.com/academy/lesson/marine-resources-characteristics-formation management.html
2. https://www.sciencelearn.org.nz/resources/145-marine-habitats

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	1	3	2	2	3	1
CO-2	1	3	3	2	1	2	3	3	2	1
CO-3	2	1	3	3	2	1	3	2	3	2
CO-4	3	2	2	3	2	3	2	1	3	3
CO-5	1	2	3	2	3	1	2	3	2	3
Ave.	2	2.2	2.6	2.6	1.8	2	2.4	2.2	2.6	2

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

PRACTICALS

Hours/Week: 2 **Course Code: 23PZOCR5** **Credit: 1**

1. Determination of acidity
2. Estimation of salinity
3. Determination of alkalinity
4. Determination of nitrite
5. Estimation of phosphate
6. Collection and identification of marine plankton (any two phyto and zooplankton)
7. Identification and comments on the following

i. Plankton net

ii. Inter-tidal organisms

a. Rocky shore: Sea anemone, Brittle star

b. Muddy shore: Uca, Cerithidia

c. Sandy shore: Arenicola, Murex

iii. Biofouling

iv. Corrosion

8. Analysis of buckle canal sample (Microbial load)
9. Extraction of fish oil using soxhlet apparatus
10. Visit to mangroves / estuaries / marine environment

Books for Reference

1. Strickland and Parsons. J.D.H. *A Practical Handbook of Seawater Analysis*, Canada: Bulletin 167, Fisheries Research Board of Canada. Second Edition 1972.
2. Kiewood Maff, D. *ICES* T*echniques in Marine Environmental Sciences*. Denmark: International Council for the Exploration of the Sea, 1987.

SEMESTER IV			
Core IX	**Developmental Zoology**		
Course Code: 23PZOC42	**Hrs/ Week: 5**	**Hrs/ Sem: 75**	**Credits: 5**

Objectives:

- To understand the sequential changes in the development and organization of an embryo
- To acquire knowledge about the metamorphosis, regeneration and role of genes in development

Course Outcomes

CO. No	**upon completion of this course, students will be able to**	**CL**
CO-1	recall the fundamental princiles of organogenesis, the early stages of ontogenic development, the function of genes in development, and post-embryonic development.	**K1**
CO-2	explain the importance of particular genes to cater signaling pathways in developmental processes and interpret the mechanisms in embryonic development.	**K2**
CO-3	apply the knowledge of developmental biology to analyze and interpret the experimental findings and utilize principles learned to predict outcomes of genetic mutations or environmental influences on development	**K3**
CO-4	appraising intricate developmental processes into their constituent elements for in-depth analysis and to assess the parallels and discrepancies in developmental trends across various animal taxa.	**K4**
CO-5	assess the validity of experimental methodologies used in developmental studies gauging their significant contributions to enhancing societal well-being through diverse means.	**K5**

Unit I **Gametogenesis and Fertilization** **(15 Hrs)**

Gametogenesis – spermatogenesis – oogenesis. Structure of gametes - sperm and egg of sea urchin and mammal – types of egg. Fertilization (biochemical, molecular aspects) in sea urchin and mammal - prevention of polyspermy. Parthenogenesis.

Unit II **Cleavage and Gastrulation** **(15 Hrs)**

Planes and patterns of cleavage – cleavage in sea urchin, Drosophila, frog, bird and mammal. Mechanism of cleavage. Fate map of sea urchin and frog. Gastrulation – morphogenetic movements - gastrulation in sea urchin and frog.

Unit III **Organogenesis** **(15 Hrs)**

Derivatives of ectoderm, mesoderm and endoderm. Organizer and Induction. Organogenesis in vertebrates –- CNS (Brain), eye, heart, kidney, digestive tube and its derivatives. Development of extraembryonic membranes in chick. Placentation in mammals - types and physiology.

Unit IV **Role of Genes in Development** **(15 Hrs)**

Nucleocytoplasmic interaction – Acetabularia. Genomic equivalence – differential gene expression – amplified genes – selective gene transcription – control of gene expression. Programmed cell death in development – Aging and senescence - Biology of senescence - cause of aging- mechanism involved in apoptosis. Teratology – malformation and disruptions – Types of teratogenic agents.

Unit V **Metamorphosis and Regeneration** **(15 Hrs)**

Metamorphosis – definition - insect metamorphosis - moulting and metamorphic changes - hormonal control of insect metamorphosis. Amphibian metamorphosis – Causation of metamorphosis - morphological, physiological, biochemical change. Regeneration – patterns – morphollaxis - epimorphosis and heteromorphosis – regeneration ability in different group of organisms - mechanism of limb regeneration in amphibian.

Books for Reference

1. Michael J.F. Barresi, Scott F. Gilbert. *Developmental Biology*. USA: OUP USA, 9th Edition. 2010.
2. Wendell Smith, C.P., Williams, P.L. and Sylvia Tread Gold. *Basic Human Embryology*. Great Britain: ELBS Edition, Pitman Publishing Ltd., 1996.
3. Banerjee, S. *A Text Book of Developmental Biology*. New Delhi: Dominant Publishers and Distributors, 2015.
4. Lewis Wolpert and Cheryll Tickle. *Principles of Development*. New Delhi: Oxford University Press, Fourth Edition, 2018.
5. Verma, P.S, Agarwal, V.K. and B.S. Tyagi. *Chordate Embryology*. New Delhi: S. Chand & Company Ltd, 14th Edition, 2010.
6. Sanjib Chattopadhyay. *An Introduction to Developmental Biology*. Kolkata: Books and Allied (P) Ltd., First Edition, 2017.

Web Resources:

1. https://www.ncbi.nlm.nih.gov/books/NBK10052/
2. https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html
3. https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/dvdy.20468
4. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293490/

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	1	1	2	2	1	2	2	2
CO-2	3	1	2	2	3	3	1	2	3	3
CO-3	1	1	3	2	2	1	1	3	2	2
CO-4	3	3	2	2	2	3	3	2	2	2
CO-5	1	1	1	2	2	1	1	1	2	2
Ave.	2.0	1.4	1.8	1.8	2.1	2.0	1.4	2.0	2.2	2.2

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

PRACTICALS

Course Code: 23PZOCR6

Hrs / Week: 2 **Credit: 1**

5. Mounting of chick blastoderm.
6. Study of effect of thyroxin in amphibian metamorphosis
7. Study of regeneration in the tail of tadpoles
8. Culture of Drosophila
9. Observation of sperm, egg, T. S. of testis and T.S. of ovary of frog.
10. Observation of sperm, egg, T.S. of testis and T.S. of ovary of mammal.
11. Observation of developmental stages of frog - cleavage, blastula, Gastrula, external gill stage and tadpole stages
12. Observation of chick embryos – 24 hrs, 48 hrs, 72 hrs, 96 hrs.
13. Types of placenta in mammals
    Diffuse Placenta – Pig
    Cotyledonary Placenta – Sheep
    Zonary Placenta – Cat
    Discoidal Placenta – Rabbit

Books for Reference

1. Verma, P.S, Agarwal, V.K. and B.S. Tyagi. *Chordate Embryology*. New Delhi: S. Chand & Company Ltd, 14th Edition, 2010.
2. Verma P. S. *A Manual of Practical Zoology Chordates.* New Delhi : S. Chand and Company Ltd, First Edition, 2007.
3. Balinsky B.I. 1976. *An Introduction to Embryology*. Japan: B.W. Saunders Company, U.S.A and Toppan Company Ltd., Fifth Edition, 2012.

SEMESTER IV			
Core X : Conservation Biology			
Course Code: 23PZOC43	**Hrs / Week: 4**	**Hrs/Sem:60**	**Credits : 4**

Objective

- To inculcate knowledge about the natural resources, biodiversity, human impacts on biodiversity and their conservation
- To impart practical approaches to disaster management, restoration of dwindling biodiversity and natural resources

Course Outcome

Co.No	Upon completion of this course, students will be able to	CL
CO-1	describe the fundamental principles, ethics and theories relevant to the conservation of biological diversity.	K1
CO-2	explain the biological, sociological and legislative perspectives for the management of flora and fauna to conserve wildlife	K2
CO-3	apply scientific principles and modern technologies to manage problems in disasters	K3
CO-4	analyse the impacts of exploitation of natural resources and threats to biodiversity and the need for conservation	K4
CO-5	evaluate the importance of sustainable use of natural resources to create healthy future	K5

Unit I Environment – Sustainable Development (12Hrs)

Environmental ethics, issues - Principles of conservation – possible solutions for sustainable development from unsustainable- Sustainable Development Goals 2030. Environmental Protection Act (1986) - Forest Conservation Act (1980), Wildlife (Protection) Act of Government of India (1972).

Unit II Conservation of Forest and Water Resources (12Hrs)

Forest resources: Use and over exploitation- deforestation- timber extraction- mining-dams and forests – tribes. conservation of forest

Water resources: Use and over exploitation of ground water – surface water

– conflicts over water- dams - benefits and problems - conservation of water.

Unit III Conservation of Land and Energy Resources (12Hrs)

Land resources: Land as a resource- land degradation-water logging, soil erosion and desertification -conservation of soil.

Energy resources: Growing energy needs – renewable and non-renewable energysources – use of alternate energy source. Role of individual in conservation of natural resources.

Unit IV Biodiversity and Conservation (12Hrs)

Biodiversity - values of biodiversity - threats to biodiversity - hotspots. i*n - situ* conservation - *ex- situ* conservation - role of organizations in conservation - NBPGR, BSI, ZSI, WWF, IUCN - Ramsar Convention.

Unit V Disaster Management (12Hrs)

Climate change - Global warming

Causes, impact and management of disasters - earthquakes - cyclone – wild fires - landslide – flood - Tsunami - Disaster Management Information System (DMIS).

Books for Reference

1. Dhulasi Brindha, V. *Environmental Studies*. Allied Publishers Pvt. Ltd., New Delhi. 2004.
2. Veer Bala Rastogi and M.S. Jayaraj. *Animal Ecology and Distribution of Animals.* Kedarnath Ramnath, Meerut – Delhi.2009.
3. Agarwal, A.C. *Environmental Biology*, Agro Botanical, Bikaner. 1999.
4. Anjaneyalu, Y.B. *Introduction to Environmental Science*, SPBS. Publications. Hyderabad. 2004
5. Kormondy Edward J. *Concepts of Ecology.* Prentice Hall of India, Pvt. Ltd.1994.
6. Odum, E.P. *Basic Ecology*. CBS College Publishing, Saunder.1983.
7. Anubhakaushik and C.P. Kaushik. *Environmental Science and Engineering*. Newage International (p) Publishers. New Delhi.2007.
8. Ravikrishnan, A. *Environmental Science and Engineering*. Sri Krishna Publications,Chennai.2010
9. Saha, T.K. *Ecology and Environmental Biology*. Books and Allied (P) Ltd.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	2	2	1	2	1	3	3	2	3	2
CO-2	3	2	3	3	3	3	3	2	3	3
CO-3	3	3	3	3	2	2	3	3	2	3
CO-4	2	2	3	2	2	3	2	2	3	3
CO-5	3	2	3	1	2	2	3	3	3	3
Ave.	2.6	2.2	2.6	2.2	2	2.6	2.8	2.4	2.8	2.8

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

Practicals

Hours/Week: 2 **Course Code : 23PZOCR6** **Credits-1**

1. Estimation of population density using Quadrat method
2. Population density study – Mark and Recapture method
3. Chart – Threatened, Endangered and Extinct species.
4. Mapping of National Parks in India with a note on important fauna
5. Mapping of Wild Life Sanctuaries in India with a note on important fauna
6. Renewable Energy Resources – Wind Energy
7. Case Study on Man Animal Conflict
8. Red Data Book
9. Measurement of Biodiversity by Shannon Wiener Index
10. Visit to an ecologically important place – National parks / Sanctuaries / Biosphere Reserve

Books for reference

1. Gareth Williams. *Techniques and Fieldwork in Ecology*. Bell & Hyman Ltd.London. 1987
2. Jaya Surya, Arumugam.N, Dulsy Fatima, Meyyan, R.P., Prasannakumar, S., Mani, A., Mariakuttikan, A., Narayanan, L.M., Nallasingam, K., Kumaresan, V. and A.M. Selvaraj. *Practical Zoology Vol-3*. Saras Publication, Nagercoil. 2013.

SEMESTER IV			
Discipline Specific Elective VI: Aquaculture			
Course Code: 23PZOE41	**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), funga 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. Schonder, S. L. *Hypophysation in Indian Major Carps.* Sathish Book Enterprises Agra.1980.
4. Pandian, I.D. Abhinandan Kumar and Rajbhushan Prasad. *Aquaculture and Biotechnology.* A. K. Publ. New Delhi. 2009.
5. Agnihotri. S. B. *Aquaculture Management and Technology*. Swastik Publication, Delhi.

2013.

6. Felix, S. *Marine and Aquaculture Biotechnology*. Agrobios, Jodhpur, India. 2010.
7. Santhanam, R., N. Ramanathan, and G. Jegathesan. *Coastal Aquaculture in India*. 1stedn. CBS Publishers, Delhi.1990.
8. Shagufta. *Fish Health and Diseases.* APH Publishing.,Corporation, New Delhi. 2012.
9. Yougesh Kumar and Rajeev Tyagi. *Aquaculture Fisheries Biotechnology and Genetics.* Mangalam Publishers & Distributors, Delhi.2013.
10. ChandraSekar. Y.S . *Fish Nutrition in Aquaculture*. Swasthik Publishers &Distributers, Delhi. 2012.
11. Rajendra Kumar Rath. *Freshwater Aquaculture*. Scientific Publishers, Jodhpur. 2011.
12. Singh, V.B. . *Fish Farming*. ALP Books, New Delhi. 2010
13. *Economics of Fish Culture Operations. FAO*- www.fao.org.docrep
14 Amitabh Patel, Sathya Narayan Pathak. *Hand Book of Aquaculture*. Pacific books International, Delhi, 2010.
15. Santosh Kumar, Manju Tembhre. *Fish and Fisheries*. New Central Book Agency (p) Ltd, Kolkata. 2010.
16. Jayakumar.S. *Basics of Fish Farming for The Beginners*.Notion Press, Chennai, 2020
17. Kamal Kishore Singh. *Fisheries and Aquatic Resources of India.* Sonali Publications, New Delhi. 2011.
18. Dr.R.K. Singh. *Fishery Resources*. Pearl Books, New Delhi. 2013.

PSO Relation Matrix

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CO-1	3	3	2	3	2	3	3	3	3	2
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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

SEMESTER – IV			
Discipline Specific Elective VI : Ornithology			
Course Code : 23PZOE42	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 3**

Objective:

- To equip students with the required knowledge to understand the taxonomic position, bird behaviour, their structural adaptation, role played by birds in the ecosystem, their importance to humans and their evolution
- To motivate the students to develop scientific attitude and to discover potential sources of entrepreneurial opportunities

Course Outcome

CO.No.	Upon completion of this course, students will be able to	CL
CO-1	recall the evolution, classification, anatomy, physiology and behaviour of birds	K1
CO-2	relate the anatomy and physiology of birds to their diversity	K2
CO-3	apply their skills to manage the threat to bird population	K3
CO-4	examine the possibility of applying biological methods to conserve birds	K4
CO-5	select an appropriate field of ornithology to empower themselves with an entrepreneurial venture	K5

Unit I Avian Evolution and Classification **12 hrs**

Origin of birds – Comparative study of birds & reptiles - Fossil history - Archeopteryx – Theories of avian origin: Theropods versus Archosaurs – Evolution of flight in birds – Geological events in the history of avian evolution and radiation – KT boundary and continental shift - Diversification of modern birds – Adaptive radiation and speciation in birds - Avian systematics – Major schools of avian classification – Species concepts - Species problems in avian classification - Brief history of classification of birds – Modern classifications – Molecular systematics.

Unit II Avian Diversity **12 hrs**

Diversity and distribution of birds of India – Modes of speciation in Indian birds – Zoogeographical affinities of Indian avifauna – Hora's Satpura Hypothesis – Dilger's

Brij hypothesis – Endemism in Indian avifauna – Endemic Bird Areas of India - Ornithogeography of Andaman and Nicobar Islands and Sri Lanka

Unit III Bird Morphology **12 hrs**

Body plan in birds – Topography – Feathers: structure, types, colour, function, and maintenance – Feathert racts and pterylosis – Moults and plumages – Annual moult cycles and moulting strategies – Moult scores – Avian flight: forms, mechanisms, and energetics. Avian anatomy: an overview – Skeletal system – Muscular system – Respiratory system – Circulatory system – Digestive system – Urogenital system – Structure and adaptations of avian sperms and eggs - Senses and nervous system in birds – Sense organs

Unit IV Bird Physiology and Reproductive Behaviour **12 hrs**

Avian eye and vision – Ears and auditory sense – Echolocation in birds – Taste and olfactory sense – Tactile sense in birds – Thermoregulation in birds - Cognition and intelligence in birds - Unique functional adaptations in birds: temperature regulation of mound-nests in megapodes, salt-excretion in seabirds, milk secretion in pigeons, torpor in night jars, and saliva-nests of swifts-Vocalization in birds –Duetting - Mimicry – Flight song – Non-vocal/mechanical sounds. Annual breeding cycle andphotoperiodism in birds – Territoriality – Pair bonds and courtship display – Mate choice- Egg dumping and brood parasitism- Kin selection and altruism

Unit V Population Ecology and Conservation **12 hrs**

Sampling methods; Concepts of bird communities-Mixed species flocks, Macro ecology; Molecular Techniques in Ornithology; Avian Disease; Citizen Science and Ornithology; Threats faced by birds; Concepts of Bird Conservation with case studies

Books for Reference

1.Lovette, I.J and Fitzpatrick, J.W. *Handbook of Bird Biology*, 3rd Edition. Wiley. 2016

2.Birkhead, T. *Bird Sense: What it's like to be a bird?* Bloomsbury, NY. 2013

3.Birkhead, T., Wimpenny, J., and Montgomerie, B. *Ten Thousand Birds: Ornithology since Darwin*. Illustrated Edition. Princeton University Press, Princeton, NJ. 2014

4.Gill, F.B, and Prum, R.O. *Ornithology*, 4th ed. Macmillan. 2019

5. Grimmett, R, Inskipp, C. Inskipp T. *Birds of the Indian Subcontinent.* 1st Edition, Bloomsbury, India. 2016

Web Resources

http://www.jnkvv.org/PDF/1304202015324213420140 0.pdf

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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