



ANNAMALAI UNIVERSITY

(Affiliated Colleges)

**406 - M.Sc. Zoology**

Programme Structure and Scheme of Examination (under CBCS)

(Applicable to the candidates admitted from the academic year 2023 -2024 onwards)

Part	Course Code	Study Components & Course Title	Credit	Hours/ Week	Maximum Marks		
					CIA	ESE	Total
		<b>SEMESTER – I</b>					
A	23PZOOC11	<b>Core - I:</b> Structure and functions of Invertebrates	5	7	25	75	100
	23PZOOC12	<b>Core - II:</b> Comparative Anatomy of Vertebrates	5	7	25	75	100
	23PZOOP13	<b>Core - III:</b> Practical – I (Covering 23PZOOC11 & 23PZOOC12)	4	6	25	75	100
	23PZOOE14-1	<b>Elective – I:</b> Molecules and their interaction relevant to Biology (or)	3	5	25	75	100
	23PZOOE14-2	Medical Entomology					
	23PZOOE15-1	<b>Elective-II :</b> Biostatistics (or)	3	5	25	75	100
	23PZOOE15-2	Toxicology					
		<b>Total</b>	<b>20</b>	<b>30</b>			<b>500</b>
		<b>SEMESTER – II</b>					
A	23PZOOC21	<b>Core - IV:</b> Cellular and Molecular Biology	5	6	25	75	100
	23PZOOC22	<b>Core - V:</b> Developmental Biology	5	6	25	75	100
	23PZOOP23	<b>Core - VI:</b> Practical - II (Covering 23PZOOC21 & 23PZOOC22)	4	6	25	75	100
	23PZOOE24-1	<b>Elective – III:</b> Economic Entomology (or)	3	4	25	75	100
	23PZOOE24-2	Biodiversity and Conservation					
	23PZOOE25-1	<b>Elective – IV:</b> Research Methodology (or)	3	4	25	75	100
	23PZOOE25-2	Basic Biotechnology					
B (i)	23PZOOS26	<b>Skill Enhancement Course (SEC-I):</b> Poultry Farming	2	4	25	75	100
		<b>Total</b>	<b>22</b>	<b>30</b>			<b>600</b>

		<b>SEMESTER – III</b>					
A	23PZOOC31	<b>Core - VII:</b> Genetics	5	6	25	75	100
	23PZOOC32	<b>Core - VIII:</b> Evolution	5	6	25	75	100
	23PZOOC33	<b>Core - IX:</b> Animal Physiology	5	6	25	75	100
	23PZOO P34	<b>Core - X:</b> Practical – III: (Covering : 23PZOOC31, 23PZOOC32 & 23PZOOC33)	4	6	25	75	100
	23PZOOE35-1 23PZOOE35-2	<b>Elective – V :</b> Stem Cell Biology (or) Endocrinology	3	3	25	75	100
B (i)	23PZOOS36	<b>Skill Enhancement Course (SEC-II) :</b> Dairy Farming	2	3	25	75	100
B (ii)	23PZOOI37	Summer Internship*	2	-	25	75	100
		<b>Total</b>	<b>26</b>	<b>30</b>			<b>700</b>
		<b>SEMESTER – IV</b>					
A	23PZOOC41	<b>Core - XI:</b> Immunology	4	5	25	75	100
	23PZOOC42	<b>Core - XII:</b> Ecology	4	5	25	75	100
	23PZOO P43	<b>Core – XIII :</b> Practical IV (Covering : 23PZOOC41 & 23PZOOC42)	2	2	25	75	100
	23PZOOD44	Project with Viva-voce	7	10	25	75	100
	23PZOOE45-1 23PZOOE45-2	<b>Elective – VI :</b> Medical Laboratory Techniques (or) Aquaculture and their by-products	3	4	25	75	100
B (i)	23PZOOS46	<b>Skill Enhancement Course (SEC-III) :</b> Intellectual Property Rights	2	4	25	75	100
C	23PZOOX47	Extension Activity	1	-	100	-	100
		<b>Total</b>	<b>23</b>	<b>30</b>			<b>700</b>
		<b>Total Credits / Hours</b>	<b>91</b>	<b>120</b>			<b>2500</b>

\* Students should complete two weeks of internship before the commencement of III semester.

**Credit Distribution**

Study Components	Papers	Total Credits	Marks/Sub	Total Marks
Core Theory	9	43	100	900
Core Electives	6	18	100	600
Core Practical	4	14	100	400
Skill Enhancement Courses SEC1, SEC2, SEC3	3	6	100	300
Internship/Industrial Activity (Carried out in Summer Vacation at the end of I Year – Two Weeks Period)	1	2	100	100
Project	1	7	100	100
Extension Activity	1	1	100	100
	<b>25</b>	<b>91</b>		<b>2500</b>

**Credit Distribution for PG Science Programme**

Part	Course Details	No. of courses	Total Credit
<b>A</b>	Core Theory	9	<b>43</b>
	Core Practical	4	<b>14</b>
	Elective Course	6	<b>18</b>
	Project Work with VIVA-VOCE	1	<b>7</b>
<b>B(i)</b>	Skill Enhancement Course	3	<b>6</b>
<b>B(ii)</b>	Summer Internship	1	<b>2</b>
<b>C</b>	Extension Activity	1	<b>1</b>
		25	<b>91</b>

**Component-wise Credit Distribution**

Part	Courses	Sem I	Sem II	Sem III	Sem IV	Total
<b>A</b>	Core (including Practical and Project)	14	14	19	17	<b>64</b>
	Elective	6	6	3	3	<b>18</b>
<b>B(i)</b>	Skill Enhancement Course	-	2	2	2	<b>6</b>
<b>B(ii)</b>	Summer Internship	-	-	2	-	<b>2</b>
<b>C</b>	Extension Activity	-	-	-	1	<b>1</b>
						<b>91</b>

Part A and B(i) component will be taken into account for CGPA calculation for the post graduate programme and the other components Part B(ii) and C have to be completed during the duration of the programme as per the norms, to be eligible for obtaining PG degree.

<p><b>Programme Outcomes (Pos)</b></p>	<p><b>PO1: Problem Solving Skill</b> Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.</p> <p><b>PO2: Decision Making Skill</b> Foster analytical and critical thinking abilities for data-based decision-making.</p> <p><b>PO3: Ethical Value</b> Ability to incorporate quality, ethical and legal value-based perspectives to all organizational activities.</p> <p><b>PO4: Communication Skill</b> Ability to develop communication, managerial and interpersonal skills.</p> <p><b>PO5: Individual and Team Leadership Skill</b> Capability to lead themselves and the team to achieve organizational goals.</p> <p><b>PO6: Employability Skill</b> Inculcate contemporary business practices to enhance employability skills in the competitive environment.</p> <p><b>PO7: Entrepreneurial Skill</b> Equip with skills and competencies to become an entrepreneur.</p> <p><b>PO8: Contribution to Society</b> Succeed in career endeavors and contribute significantly to society.</p> <p><b>PO 9 Multicultural competence</b> Possess knowledge of the values and beliefs of multiple cultures and a global perspective.</p> <p><b>PO 10: Moral and ethical awareness/reasoning</b> Ability to embrace moral/ethical values in conducting one's life.</p>
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<p><b>Programme Specific Outcomes (PSOs)</b></p>	<p><b>PSO1 – Placement</b> To prepare the students who will demonstrate respectful engagement with others’ ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions.</p> <p><b>PSO 2 - Entrepreneur</b> To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.</p> <p><b>PSO3 – Research and Development</b> Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.</p> <p><b>PSO4 – Contribution to Business World</b> To produce employable, ethical and innovative professionals to sustain in the dynamic business world.</p> <p><b>PSO 5 – Contribution to the Society</b> To contribute to the development of the society by collaborating with stakeholders for mutual benefit.</p>
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Semester	23PZOOC11: CORE COURSE - I	H/W	C
I	STRUCTURE AND FUNCTIONS OF INVERTEBRATES	7	5

**Course Objective:**

1	To understand the concept of classification and their characteristic features of major group of invertebrates.
2	To realize the range of diversification of invertebrate animals.
3	To enable to find out the ancestors or derivatives of any taxon.
4	To know the functional morphology of system biology of invertebrates.

**UNIT - I:** Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy

**UNIT - II:** Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata

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

**UNIT - IV:** Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malpighian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervoussystem: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda); Trends in neural evolution

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

### Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.
2	Understand the evolutionary process. All are linked in a sequence of life patterns.
3	Apply this for pre-professional work in agriculture and conservation of life forms.
4	Evaluate and to create the perfect phylogenetic relationship in classification.

### TEXT BOOKS

1. Arumugam, N., T. Murugan, B. Ramanathan and M.G. Ragunathan. (2019). *A Text Book of Invertebrates*, Saras Publications, Nagercoil, Tamil Nadu.
2. Ekambaranatha Ayyar, M. (1973). *A Manual of Zoology – Part I: Invertebrata*. S.Viswanathan (Printers and Publishers) Pvt., Ltd. Madras.
3. Ekambaranatha Ayyar, M. (1973). *A Manual of Zoology Part – II: Chordata*. S.Vishvanathan Printers and Publishers, Pvt. Ltd., Madras.
4. Jordan, E. L. and P. S. Verma, (2017). *Chordate Zoology and Elements of Animal Physiology*, S. Chand & Co., Ltd., New Delhi.
5. Jordon, E. L. and P.S Verma, (2015). *Invertebrate Zoology*. S. Chand and Co. Ltd., New Delhi.
6. Saxena, R.K. and S. Saxena. (2015). *Comparative Anatomy of Vertebrates*, M.V.Learning, UK.
7. Wells, H.G. (2018). *Text Book of Biology, Part 1: Vertebrata*, Createspace Publishing Company, USA.

### REFERENCE BOOKS

1. Arumugam, N. (2014). *Animal diversity Volume - 1 – Invertebrata*. Saras Publication, Nagercoil, Tamil Nadu.
2. Arumugam, N. (2014). *Animal diversity Volume - 2 – Chordata*. Saras Publication, Nagercoil, Tamil Nadu.
3. Barrington E. J. W. (2012). *Invertebrate structure and function*. Affiliated EastWest Press Pvt. Ltd., New Delhi.
4. Brusca, R.C., W. Moore and S.M. Shuster. (2016). *Invertebrates*. Oxford University Press, USA.
5. Kent, G.C. (2015). *Comparative Anatomy of the Vertebrates*. McGraw Hill, NewYork.

**Outcome Mapping**

<b>Mapping with Programme Outcomes*</b>										
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	3	3	2	3	3	3	2	3	3	3
<b>CO2</b>	3	3	2	2	3	3	2	2	3	3
<b>CO3</b>	3	2	3	2	3	3	2	2	3	3
<b>CO4</b>	3	2	3	2	3	3	2	2	3	2
<b>CO5</b>	3	2	3	2	3	3	2	2	3	2

\*3 - Strong; 2 - Medium; 1– Low



Semester	23PZOOC12: CORE COURSE - II	H/W	C
I	COMPARATIVE ANATOMY OF VERTEBRATES	7	5

**Course Objective:**

1	Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.
2	Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.
3	Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals
4	Imparting conceptual knowledge about the animal life in the air and their behaviours.
5	Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.

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

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

**UNIT - IV:** Skeletal system: Form, function, body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrates series

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

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

<b>1</b>	Understand the morphological features and physiological functions like Respiration, reproduction and nervous system of Vertebrates
<b>2</b>	Understand the various salient features of higher Vertebrates
<b>3</b>	Differentiate the patterns of functioning of various organ systems in vertebrates
<b>4</b>	Know the structural organization and functioning of various organs in Vertebrates.

**TEXT BOOKS**

1. Ekambaranatha Ayyar, M. (1973). *A Manual of Zoology Part – II: Chordata*. S. Vishvanathan Printers and Publishers, Pvt. Ltd., Madras.
2. Jordan, E. L. and P. S Verma. (2017). *Chordate Zoology and Elements of Animal Physiology*, S. Chand & Co., Ltd., New Delhi.
3. Saxena, R.K. and S. Saxena. (2015). *Comparative Anatomy of Vertebrates*, M.V.Learning, UK.
4. Wells, H.G. (2018). *Text Book of Biology, Part 1: Vertebrata*, Createspace Publishing Company, USA.
5. Young, J.Z. (2004). *The life of Vertebrates*. Oxford University Press, Oxford

**REFERENCE BOOKS**

1. Arumugam, N. (2014). *Animal diversity Volume-2: Chordata*. Saras Publication, Nagercoil, Tamil Nadu.
2. Kent, G.C. (2015). *Comparative Anatomy of the Vertebrates*. McGraw Hill, New York, USA.

**Outcome Mapping**

<b>Mapping with Programme Outcomes*</b>										
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	3	2	1	3	2	3	2	3	2	3
<b>CO2</b>	3	1	1	3	2	3	2	2	2	2
<b>CO3</b>	3	2	1	3	2	3	2	1	2	2
<b>CO4</b>	3	1	1	3	1	3	2	1	2	1
<b>CO5</b>	3	2	1	3	3	3	2	3	2	2

\*3 - Strong; 2 - Medium; 1– Low

Semester	23PZOO13: CORE COURSE - III	H/W	C
I	PRACTICAL I - INVERTEBRATES & VERTEBRATES	6	4

**Course Objective:**

1	Understand the structure and functions of various systems in animals
2	Learn the adaptive features of different groups of animals
3	Learn the mounting techniques
4	Acquire strong knowledge on the animal skeletal system
5	Understand the structure and functions of various systems in animals

**INVERTEBRATES****Dissection**

Earthworm	: Nervous system
<i>Pila</i>	: Digestive and nervous systems
<i>Sepia</i>	: 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

**CHORDATES****Study the nervous system of Indian dog shark - Dissection**

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

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

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

**Study of the different types of scales in fishes**

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

**Study of the frog skeleton system (Representative samples)**

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

## Mounting

1. Weberian ossicles of fish

## Text Books:

1. Lal, S.S. 2009. Practical Zoology, Rastogi Publications, pp-484.
2. Iuliis G. D. and D. Pulerà, 2007. The Dissection of Vertebrates: A Laboratory Manual. Academic Press, Imprint of Elsevier Publication, pp-416.
3. Verma, P.S. 2000. Manual of Practical Zoology: Chordates, S. Chand Publishing Company, pp-528

## Reference Books:

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

## Outcome Mapping

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	3	3	2	3	2	3
CO2	3	2	1	3	2	3	2	2	2	2
CO3	2	2	1	3	1	3	2	1	2	2
CO4	3	3	1	3	1	3	2	1	2	1
CO5	3	3	2	1	2	3	2	3	2	2

\*3 - Strong; 2 - Medium; 1 - Low

**ELECTIVE COURSES:**

Semester	Elective Course - I : (Generic / Discipline Centric):	H/W	C
I	<b>23PZOOE14-1: MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY</b>	5	3

**Course Objectives (CO):**

The main objectives of this course are:

1	To learn the structure, properties, metabolism and bioenergetics of biomolecules
2	To acquire knowledge on various types of enzymes, classification, their mechanism of action and regulation
3	To understand the importance and applications of methods in conforming the structure of biopolymers
4	To know the structural organization of proteins, carbohydrates, nucleic acids and lipids
5	To familiarize the use of methods for the identification, characterization and conformation of biopolymer structures

**UNIT - I:** Basics of biophysical chemistry and biochemistry: Structure of atoms, molecules and chemical bonds - Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).

**UNIT - II:** Biomolecular interactions and their properties: Stabilizing interactions (Vander Waals, electrostatic, hydrogen bonding, hydrophobic interaction etc. - Composition, structure, metabolism and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).

**UNIT - III:** Bioenergetics and enzymology: 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: 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: Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage.

**Expected Course Outcome (CO)**

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

1	Learn the structure, properties, metabolism and bioenergetics of biomolecules
2	Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation
3	Understand the fundamentals of biophysical chemistry and biochemistry, importance and applications of methods in conforming the structure of biopolymers
4	Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids
6	Familiarize the use of methods for the identification, characterization and conformation of biopolymer structures

**Text Books**

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

**Reference Books**

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

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

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



Semester	Elective Course - I : (Generic / Discipline Centric):	H/W	C
I	23PZOOE14-2: MEDICAL ENTOMOLOGY	5	3

**Course Objectives (CO):**

The main objectives of this course are:

1	To acquire Knowledge of the Classification of Arthropod Vector insects in Medical Entomology.
2	To study the life Cycles of Vector Insects.
3	To Learn Various Vector borne diseases - Transmission and Control Measures.

**UNIT - 1:Introduction**

Scope of Medical Entomology- Classification of Arthropoda. Classification of Arthropods of Medical and Public Health importance. Mechanism of Transmission of diseases by Arthropods - Mechanical and Biological; Metamorphosis – Complete and Incomplete. Insect Mouth Parts – Chewing and Sucking.

**UNIT - 2: Mosquitoes and Louse**

MOSQUITO: Morphology – Life history, vectors - diseases transmission– Control Measures.

LOUSE :- Morphology - Life history - Public Health importance – Control Measures

**UNIT - 3 : Tsetse fly and Sand fly**

TSETSE FLY: Morphology - Life history - Public Health importance - Control Measures.

SAND FLY :- Morphology – Life history - Public Health importance – Control Measures.

**UNIT - 4 : Fleas and House fly**

FLEAS: Morphology – Life history - Public Health importance – Control Measures.

HOUSE FLY:- Morphology – Life history - Public Health importance – Control Measures.

**.UNIT - 5 : Ticks and Mites**

TICKS : Morphology - Life history - Public Health importance – Control Measures.

MITES : Morphology – Life history - Public Health importance – Control Measures.

**Expected Course Outcome (CO)**

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

<b>1</b>	<b>Identify insects based on morphological features</b>
<b>2</b>	<b>Start entrepreneurial activities</b>
<b>3</b>	<b>Take up jobs in vector control and public health departments</b>
<b>4</b>	<b>Take up integrated pest management activities</b>

**Text Books:**

1. Tembhare, D.B. (2012). *Modern Entomology*, Himalaya Publishing House, New Delhi.
2. Tyagi, B.K. (2012). *Medical Entomology*, Scientific publishers, Chennai

**Reference Book**

1. Rathanswamy, G.K, (2010). A Hand book of Medical Entomology.  
S.Viswanatham Printers & Private & Ltd., Chennai
2. Vasantharaj Devid, and V.V. Ramamurthy, (2011). Elements of Economic Entomology. Namrutha Publications, Chennai -600116

**Outcome Mapping**

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
<b>CO1</b>	S	S	S	S	L	S	S	S	S	S
<b>CO2</b>	S	S	S	S	L	S	S	S	M	S
<b>CO3</b>	M	S	S	S	L	S	S	S	S	S
<b>CO4</b>	S	S	S	S	L	S	S	S	S	S

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

Semester  I	Elective Course - II: (Generic / Discipline Centric):  23PZOOE15-1: BIOSTATISTICS	H/W	C
		5	3

**Course Objectives (CO):**

The main objectives of this course are:

1	To understand the importance of analysis of qualitative and quantitative information from biological studies.
2	To acquire skills to perform various statistical analyses using modern statistical techniques and software.
3	To Know the merits and limitation of practical problems in biological/ health management study
4	To propose and implement appropriate statistical design/ methods of analysis.

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

**UNIT - II:** Measures of central tendency: 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: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.

**UNIT - IV:** Hypothesis testing: Students 't' test - paired sample and mean difference 't' tests. Correlation: Types - Karl Pearson's Co-efficient, Rank correlation, Significance test for correlation coefficients.

**UNIT - V:** Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction. Analysis of variance: one way and two way classification.

**Expected Course Outcome (CO)**

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

1	Clear understanding of design and application of biostatistics relevant to experimental and population studies.
2	Acquired skills to perform various statistical analyses using modern statistical techniques and software.
3	Knowledge on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate statistical design/

methods of analysis.
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### Text Books

1. Arora, P. N. and P. K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp-447.
2. Gurumani, N. 2005. Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp-407.
3. Das, D. and A. Das. 2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata, pp-363.
4. Palanichamy, S. and Manoharan, M. 1990. Statistical Methods for Biologists, Palani Paramount Publications, Tamil Nadu, pp-264.

### Reference Books

1. Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp-48.
2. Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467.
3. Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp-859.
4. Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660.
5. Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.
6. Wayne W. Daniel. Biostatistics: A Foundation for Analysis in the Health Sciences, John Wiley & Sons Inc, USA, pp-443.
7. Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp-593.
8. Pagano, M. and K. Gauvreau. 2008. Principles of Biostatistics (Second Edition), Cengage Learning, New Delhi, pp-525.

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

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

Semester	Elective Course - II : (Generic / Discipline Centric):	H/W	C
I	23PZOOE15-2: TOXICOLOGY	5	3

**Course Objectives (CO):**

The main objectives of this course are:

1	To learn the concepts and processes involved in toxicology
2	To understand the various methods to know absorption and distribution of toxicants
3	To study the biotransformation and excretion of toxicants
4	To learn the impacts of toxicants and human beings.
5	To learn the application of antidotes

**UNIT - I: Introduction to Toxicology**

Definition – Brief history of toxicology– Toxicity methods – Acute toxicity tests – Sub-acute toxicity test – Chronic toxicity test – Bio-assay – Determination of LC<sub>50</sub> and LD<sub>50</sub> – Dose - Response relationship.

**UNIT - II: Exposure Route, Absorption and Distribution of Toxicants**

Route of exposure of Toxicants: Dermal route – Inhalation route – Ingestion route. Absorption of Toxicants: Introduction – Mechanism of absorption – Passive transport and carrier mediated transport – Factors affecting absorption. Distribution of Toxicants: Membrane barriers.

**UNIT - III: Biotransformation and Excretion of Toxicants**

Biotransformation: Pattern of Biotransformation - Phase I reaction – Oxidation – Mixed Function Oxidase System – Reduction reaction – Hydrolysis – Phase II reaction – Biochemical conjugation – Glucuronidation – conjugation with Glutathione – Sulphate conjugation – Acetylation and Methylation – Amino acid conjugation - Excretion of Toxicants: Urinary excretion – Biliary excretion.

**UNIT - IV: Toxic effects on human**

Categories of toxic effects – Local and systemic effects – Reversible and irreversible effects – Immediate and delayed effects - Effects on target organs: Neurotoxic effects – Hepatotoxic effects – Genotoxic effects – mutagenic – Teratogenic – carcinogenic effects.

**UNIT - V: Antidotes**

Antidotes: Classification of antidotes– Mechanism of action of antidotes-Specific antidotes for metals and pesticides.

**Expected Course Outcome (CO)**

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

1	Carry out toxicological analysis of various environmental samples
2	Make observations and biochemical analysis of biological samples
3	Carry out toxicological testing using live specimen to determine toxicity of toxicants
4	Take up jobs in toxicological research institutions and clinical labs

### TEXT BOOKS

1. Lee, B.M. and S.Kacew. (2018). *Lu's Basic Toxicology*, Informa Healthcare.
2. Sharma, P. D., (1996). *Environmental biology and toxicology*. Rastogi Publication, Meerut, India
3. Frank C. Lu (1985). *Lu's Basic Toxicology*. Hemisphere Publication Corporation Washington, N.Y. London.
4. Gupta, P.K., and Salunka, D.K., (1985). *Modern Toxicology*. Vol. I and II, Metropolitan, New Delhi.
5. Pandey, K., J. P. Shukla and S. P. Trivedi. (2013). *Fundamentals of Toxicology*, New Central Book Agency, New Delhi.
6. Chris Kent (1998). *Basics of Toxicology*. John Wiley & Sons. New York

### REFERENCE BOOKS

1. Vija Byung-Mu Lee, Sam Kacew and Hyung Sik Kim. (2017). *Lu's Basic Toxicology: Fundamentals, Target Organs, and Risk Assessment*. CRC Press, USA.
2. Stephen M. Roberts, Robert C. James and Phillip L. Williams. (2015). *Principles of Toxicology: Environmental and Industrial Applications*. Wiley Blackwell.
3. Frank A. Barile. (2017). *Principles of Toxicology Testing*. CRC Press, USA.
4. Karen E. Stine and Thomas M. Brown. (2015). *Principles of Toxicology*. CRC Press, USA.
5. Barile, F.A. (2013). *Principles of Toxicology Testing*, CRC Press.
6. Kamaleshwar Pandey, J. P. Shukla and S. P. Trivedi. (2011). *Fundamentals of Toxicology*. New Central Book Agency, New Delhi.

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

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

Semester	23PZOOC21: CORE COURSE - IV	H/W	C
II	CELLULAR AND MOLECULAR BIOLOGY	6	5

**Course Objective :**

1	To understand the molecular basis of cell structure and functions
2	To learn the structure and functions of various organization and cell membrane.
3	To learn bioenergetics and biogenesis
4	To learn structure and replication of DNA
5	To learn various molecular techniques

**UNIT - I:** General features of the cell: Basic structure of prokaryotic and eukaryotic cells - Protoplasm and deutoplasm - cell organelles; cell theory; Diversity of cell size and shapes.

**UNIT - II** Cellular organization: Membrane structure and functions - Structure of model membrane, lipid bilayer and membrane proteins diffusion, osmosis, ion channels, active transport, ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles and chloroplasts.

**UNIT - III** Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Molecular biology of cell: Structure of DNA and RNA; Process of DNA replication, transcription and translation in pro- and eukaryotic cells; Genetic maps.

**UNIT - IV:** Cell communication and cell signalling: Membrane- associated receptors for peptide and steroid hormones - signalling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures

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

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

1	Acquire knowledge on cellular structure and functions.
2	Understand the process of energetic and genesis in cells
3	Interpret the structural and functional significances of DNA and RNA
4	Take up jobs in molecular biology labs and clinical labs

**TEXT BOOKS**

1. De Robertis E.D.D and De. Robertis E.M.F. (2017). *Cell and Molecular Biology*. Lippincott Williams & Wilkins , USA.
2. Pollard, T.D., W.C. Earnshaw, J.L .Schwartz and G. Johnson. (2017). *Cell Biology*, Elsevier.
3. Verma P.S. and V.K. Agarwal, (2015): *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*, S. Chand and Company, New Delhi.
4. Gupta. P.K., (2003). *Cell and Molecular Biology*, Rastogi Publication, Meerut, India.
5. Lodish. H, Berk. A, Zipursky. SL, Matiudaira. P, Baltimore. D and Darnell J. (2000). *Molecular Biology of the cell*, W.H. Freeman and company, New York.
6. Lewin.B, (2000). *Gene VII*, Oxford University Press, London.

#### REFERENCE BOOKS

- 1) Verma P.S. and V.K. Agarwal. (2016). *Cell Biology*. S. Chand & Co., New Delhi.
- 2) Arnold Berk, Chris A. Kaiser and Harvey Ledish. (2016). *Molecular Cell Biology*. WH Freeman, USA.
- 3) Malathi, V. (2012). *Essentials of Biology*. Pearson Education, Chennai, India.
- 4) Bruce Alberts, Alexander D. Johnson and Julian Lewis. (2014). *Molecular Biology of the Cell*. W.W. Norton & Co., USA.
- 5) Geoffrey M.Cooper and Robert E. Hausman. (2013). *The Cell: A Molecular Approach*. Sinauer Associates Inc., USA.

#### Outcome Mapping

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	1	1	1	1	3	3	3	2	2	2
CO2	2	2	2	3	3	3	3	2	3	2
CO3	3	3	3	2	2	3	2	2	1	3
CO4	2	2	3	1	3	3	1	2	3	3
CO5	3	2	2	3	3	3	3	2	3	3

\*3 - Strong; 2 - Medium; 1–Low



Semester	23PZOOC22: CORE COURSE - V	H/W	C
II	DEVELOPMENTAL BIOLOGY	6	5

**Course Objective:**

1	Define the concepts of embryonic development
2	Observe various stages of cell divisions under microscope
3	Understand the formation of zygote
4	Differentiate the blastula and gastrula stages
5	Learn the distinguishing features of three different germ layers and formation of various tissues and organs

**UNIT - I** Pattern of animal development: Chief events in animal development; History of thoughts and conceptual developments. Gametogenesis: Origin of germ cells, spermatogenesis - Sperm morphology in relation to the type of fertilization, Oogenesis - Oogenesis in insects and amphibians; Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians

**UNIT - II:** Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitating in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg - Egg activation - Intracellular calcium release - Cortical reaction - Physiological polyspermy - Fusion of male and female pronuclei - Post fertilization metabolic activation – Parthenogenesis

**UNIT - III:** Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition - Determinate and regulatory embryos, Factors affecting gastrulation, mechanisms and types of gastrulation in respective animal embryos (Sea urchin, *Amphioxus*, Amphibians, Aves, Mammals); Fate maps - (Amphibian and Chick), Epigenesis and preformation – Formation of primary germ layers.

**UNIT – IV:** Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation; Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Gene and development; Anterior- posterior axis in determination in drosophila, Maternal effect genes - *Bicoid* and *Nanos* proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes

**UNIT - V:** Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Formation of ectodermal cap and regeneration blastema – Types of regeneration in planaria, Regenerative ability in different animal groups, Factors stimulating regeneration – Biochemical changes associated with regeneration. Aging and

senescences: Biology of senescences- cause of aging- mechanism involved in apoptosis. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Endocrine changes associated with normal pregnancy, Induced ovulation in humans – Cryopreservation of gametes/embryos - Ethical issues in cryopreservation

### Expected Course Outcomes (CO)

At the end of the course, the student will be able to

1	Acquire knowledge on reproduction and development
2	Understand process of fertilization
3	Understand the whole process of embryogenesis
4	Acquisition of skills in common methods and practices followed in developmental biology related laboratory activities and Take up jobs in fertility clinics and research labs

### TEXT BOOKS

1. Verma, P.S. and V.K. Agarwal. (2017). *Chordate Embryology (Developmental Biology)*, S. Chand and Co., New Delhi.
2. Arora, P. Mohan, (2014). *Embryology*, Himalaya publishing House, New Delhi.
3. Arumugam, N. (2014). *A Text Book of Embryology (Developmental Biology)*, Saras Publications, Nagercoil, Tamil Nadu.
4. Balinsky, B.I. (2012). *An Introduction to embryology*, 4<sup>th</sup> Edition, Saunder's College Publishing Ltd, New York
5. Philip Grant (1977). *Biology of development systems*, University of Oregon
6. Berrill, N.J., and G. Karp. (1978). *Development Biology*, Tata McGraw Hill Publishing Co., Ltd, New Delhi

### REFERENCE BOOKS

- 1) Madhavan K. S. (2018). *Developmental Biology*. Arjun Publishing House.
- 2) Subhadra Devi, V. (2018). *Inderbir Singh's Human Embryology*, Jaypee Brothers Medical Publishers, New Delhi.
- 3) Berry A.K. (2016). *An Introduction to Embryology*. Emkay Publications, New Delhi.
- 4) Lewis Wolpert, Cheryll Tickle and Alfonso Martinez Arias. (2015). *Principles of Development*. Oxford University Press, USA.
- 5) Jain P.C. (2013). *Elements of Developmental Biology*. Vishal Publishing Co., Punjab.
- 6) Carlson, B.M. (2014). *Pattens foundations of Embryology*, McGraw Hill
- 7) Sastry K.V. and Vinita Shukal. (2012). *Developmental Biology*. Rastogi Publication, Meerut, Uttar Pradesh.

**Outcome Mapping**

<b>Mapping with Programme Outcomes*</b>										
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	3	3	2	3	3	1	3	2	1	2
<b>CO2</b>	3	3	3	3	3	1	3	3	3	3
<b>CO3</b>	3	2	3	3	3	3	3	1	1	2
<b>CO4</b>	3	3	3	3	3	2	3	3	3	1
<b>CO5</b>	3	3	3	2	3	3	3	1	1	2

\*3 - strong; 2 - Medium; 1 – Low

Semester	23PZOOP23: CORE COURSE – VI PRACTICAL II – CELLULAR AND MOLECULAR BIOLOGY AND DEVELOPMENTAL BIOLOGY	H/W	C
II		6	4

**Course Objective :**

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

**CELLULAR AND MOLECULAR BIOLOGY**

1. Determination of cell size using micrometer
2. Mitosis in root meristematic cells of plants
3. Identification of various stages of meiosis in the testes of grasshopper
4. Detection of polytene chromosome in salivary gland cells of the larvae of the Chironomus
5. Detection of sex chromatin
6. Identification of blood cells in the haemolymph of the of the cockroach
7. Isolation of genomic DNA from eukaryotic tissue
8. Isolation of total RNA from bacterial cells/tissues
9. Agarose gel electrophoresis of DNA
10. SDS-Polyacrylamide gel electrophoresis

## DEVELOPMENTAL BIOLOGY

Gametogenesis - Observation of gametes from gonadal tissue sections

- i. Oogenesis:
  - ✓ Section through ovary of shrimp, fish, frog and mammals
- ii Spermatogenesis:
  - ✓ Section through testis of shrimp, fish, calotes and mammals

Fertilization

- iii Induced spawning in polychaete worm *Hydroids elegans*
- iv *In vitro* fertilization and development in a polychaete worm *Hydroids elegans*
- v Observation of egg developmental stages in *Emerita emeritus*

Embryogenesis

- vi Observation and whole mount preparation of the chick blastoderm - 18 hours of development
- vii Chick embryonic stage - 24 hours of development
- viii Chick embryonic stage - 48 hours of development
- ix Chick embryonic stage - 72 hours of development
- x Chick embryonic stage - 96 hours of development

Histological observation: Section through various developmental stages in chick embryo

Experimental Embryology

Regeneration in Frog Tadpoles

- xi Blastema formation
- xii Demonstration of regenerative process in tadpole

Metamorphosis

- xiii Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine

Cryopreservation

- xiv Demonstration of cryopreservation of gametes of fin fish/shell fish

### Outcome Mapping

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	3	3	3	3	3	1	1	2
CO2	3	3	3	3	3	2	2	2	2	2
CO3	3	3	2	3	3	1	3	2	1	2
CO4	2	2	1	2	1	2	2	3	2	1
CO5	3	3	2	1	3	2	1	3	3	3

\*3 - Strong; 2 -Medium; 1-Low

Semester	Elective Course - III: (Generic / Discipline Centric):	H/W	C
II	23PZOOE24-1 : ECONOMIC ENTOMOLOGY	4	3

### Course Objectives (CO):

The main objectives of this course are:

1	To understand taxonomy, classification and life cycle of insects.
2	To know the method of rearing and management of diseases of beneficial insects.
3	To know the type of harmful insects, and their damage potential
4	To recognize insects which act as vectors causing diseases in animals and human.

**UNIT - I:** Basic morphological concepts – Insect taxonomy upto orders – salient features with suitable examples of the insect orders – Odonata, Orthoptera, Coleoptera, Lepidoptera and Diptera. Elementary knowledge on insect system and function.

**UNIT - II:** Beneficial insects: Silkworm – types, life history, disease management and rearing methods - types of honey bees, life history, social organization, structural adaptation and beehive. Lac insects – life history, lac cultivation.

**UNIT – III:** Destructive insects: Insect pests - definition – categories of pests – types of damage to plants by insects – causes of pest outbreak – Economic threshold level – Biology of Paddy, cotton, sugarcane pests.

**UNIT – IV:** Pest management/Control strategies: Methods and principles of pest control - Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control - Development and uses of pest resistant plant varieties - Integrated pest management - Concepts and practice.

**UNIT - V:** Vector biology and control: Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures.

**Expected Course Outcome (CO)**

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

1	Understand taxonomy and classification of insects
2	Know the life cycle, rearing and management of diseases of beneficial insects.
3	Know the type of harmful insects, life cycle, damage potential and management of pests including natural pest control
4	Recognize insects which act as vectors causing diseases in animals and human.
5	Overall understanding on the importance of insects in human life.

**Test Books**

1. Ayyar, L.V. R. 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi, pp- 528.
2. Vasantharaj David, B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.
3. Ross. H.H. 1965. A Text Book of Entomology, John Wiley & Sons Inc., New York, pp-746.

**Reference Books**

1. Chapman, R.F., S.J. Simpson and A.E. Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
2. Imms, A.D., O.W. Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.
3. Daly, H.V., J.T. Doyen and P.R. Ehrlich. 1978. Introduction to Insect Biology and Diversity. Mc Graw-Hill Kogakusha Ltd., Tokyo, pp-564.
4. Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.
5. Krishnaswami, S. 1973. Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
6. Mani, M.S. 1982. General Entomology. Oxford & IBH Publishing Co., pp-912.
7. Wigglesworth, V.B. 1972. The Principles of Insect Physiology, ELBS & Chapman and Hall, London, pp-827.

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

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

Semester	Elective Course - III: (Generic / Discipline Centric):	H/W	C
II	23PZOOE24-2 : Biodiversity and Conservation	4	3

**Course Objectives (CO):**

The main objectives of this course are:

1	To make students to realize the structure and function of ecosystem.
2	To make students to realize the wealth of our natural resources
3	To make students to realize the conservation measures to be taken
4	To make students to realize to create awareness of the laws governing environment.

**Unit – I: Ecosystem**

Composition of atmosphere – structure and stratification of atmosphere - Hydrological cycle-kinds of ecosystem-structure and functions of ecosystem-energy flow in ecosystem-trophic levels

**Unit – II: Natural Resources and Conservation**

Types of resources-conventional and non-conventional sources of energy-conservation of soil, land and forest - Deforestation and Afforestation – Conservation strategies (WCS & NCS) - Wild life management in India.

**Unit – III: Air and Water Pollution**

Air pollution-types of air pollutants-classification and effect of pollutants on vegetation, farm animals and human health-prevention and control of air pollution.

Water pollution-sources of water pollution-water quality standards – Eutrophication-prevention and control of water pollution.

**Unit – IV: Radiation, Noise and Industrial Pollution**

Radiation pollution-sources and effects of ionizing radiation.

Noise pollution – sources of noise pollution – effects of noise pollution – control measures.

Pollution control and abatement on cement industry – leather industry – textile industry.

**Unit – V: Environmental Impact Assessment and Law**

The objective of Environmental Impact Assessment (EIA) – Environmental Appraised Committee (EAC) – The Environmental Management Plan (EMP) – Control of Environmental pollution through law – Environmental Protection Act (1986).

**Expected Course Outcome (CO)**

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

1	Realize the structure and function of ecosystem.
2	Understand the wealth of our natural resources
3	Know the methods of conservation of natural resources
4	Create awareness of the laws governing environment.



**Text Books**

1. Sharma.P.D., 1995. Environmental Biology and Toxicology. Rastogi and Company, Meerut, India.
2. Trivedi P.R.,& Gurdeepraj., 1992. Environmental Biology. Akashdeep Publishing House, New Delhi.
3. Pal, B.P.,1982 Environmental Conservation and Development, Nataraj Publishers, Dehra Dun, India.
4. Agarwal, K.C., 1989. Environmental Biology. Agro Botanical Publishers, India.

**Reference Books**

5. Trivedi, P.R.& Gurdeepraj., 1992. Water Pollution. Akashdeep Publishing house, New Delhi.
6. Break Mely, W.1980. Chemicals in the Environment. Marshal Dokker INC Newyork.
7. Irving Sax, N.1974. Industrial Pollution. Van Nostrand Raingold Co., Newyork.
8. Pandey G.N.& G.C.Carney, 1989. Environmental Engineering. Tata McGraw-Hill Publishing Co., Ltd.

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

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

Semester	Elective Course - IV: (Generic / Discipline Centric):	H/W	C
II	23PZOOE25-1 : RESEARCH METHODOLOGY	4	3

**Course Objectives (CO):**

The main objectives of this course are:

1	To understand the Good Laboratory Practices
2	To learn the working principles of different instruments
3	To gain the knowledge on techniques of histology and histochemistry
4	To acquire knowledge on the basic principle and application of various modules of light and electron microscopy

**UNIT - I:** Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry

**UNIT - II:** Histology, Histochemistry, Bioinformatics and Electron microscopy.

**UNIT – III:** Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy.

**UNIT – IV:**Centrifuges, Chromatography, Electrophoresis, HPLC, GC-MS, PCR, ELISA and blotting

**UNIT - V:** Principles and Applications of tracer techniques in biology, Animal cell culture techniques.

**Expected Course Outcome (CO)**

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

1	Understand the implications of GLP
2	Learn the working principles of different instruments
3	Gain the knowledge on techniques of histology and histochemistry
4	Acquire knowledge on the basic principle and application of various modules of light and electron microscopy

**Text Books**

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

**Reference books**

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

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

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

Semester	Elective Course - IV: (Generic / Discipline Centric):	H/W	C
II	23PZOOE25-2 : BASIC BIOTECHNOLOGY	4	3

**Course Objectives (CO):**

The main objectives of this course are:

1	To learn the basic concepts in biotechnology
2	To learn the various techniques used in biotechnology
3	To acquire biotechnological knowledge related to medical, agricultural and environmental disciplines

**UNIT - I: Introduction**

Definition – Scope – Achievements of Biotechnology – Enzymes in genetic engineering - Restriction Enzymes, DNA ligase, DNA polymerase of Cloning vectors – Plasmids- Bacteriophage, Cosmids, Yeast plasmids.

**UNIT - II: Techniques in Biotechnology**

Southern blotting, Northern blotting, Western blotting, In-situ hybridization, DNA sequencing, PCR, DNA finger printing.

**UNIT - III: Medical Biotechnology**

rDNA Technology - Insulin, Somatotrophin, Somatostatin - hormone production, vaccines, interferons, gene therapy, monoclonal antibodies, Human Genome Project (HGP).

**UNIT - IV: Agricultural Biotechnology**

Micropropagation, protoplast culture, Biofertilizers - Symbiotic and Non symbiotic nitrogen fixation, Biopesticides - Transgenic plants and animals.

**UNIT - V: Microbial and Environmental Biotechnology**

Bioreactor, primary metabolites – Vitamins, alcohols, Secondary metabolites – Antibiotics, Toxins, Microbial enzyme production – amylase. Bioremediation, Microbial leaching.

**Expected Course Outcome (CO)**

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

1	Gain knowledge on the principles of biotechnology
2	Know various experiments related to biotechnology
3	Carry out biotechnological applications in the fields of medicine, agriculture and environmental fields
4	Equip themselves to take up jobs in various biotechnological companies and labs

**TEXT BOOKS**

1. Dubey. R. C., (2018). *A Text Book of Biotechnology*. S. Chand & Co. Ltd., New Delhi.
2. Lohar, P.S. (2014). *Text Book Of Biotechnology*, MJP Publishers, Chennai, Tamil Nadu.
3. Glick, B.R. and C.L Patten. (2018). *Molecular Biotechnology : Principles and Applications of Recombinant DNA*, ASM Pres, USA.
4. Clark, D.P. and N.J. Pazdernik. (2017). *Biotechnology*, Academic Cell.
5. Lohar, P.S. (2017). *Biotechnology*, MJP Publishers, Chennai, Tamil Nadu.
6. Gupta. P. K., (2009). *Elements of Biotechnology*. Rastogi & Company, Meerut.
7. Purohit, S. S. (2007). *Biotechnology, Fundamentals and Applications*. Agrobios, New Delhi.

**REFERENCE BOOKS**

1. Bernard R. Glick and Chery L Patten. (2017). *Molecular Biotechnology*. Taylor & Francis.
2. William J. Thieman and Michael A. Palladino. (2014). *Introduction to Biotechnology*. Pearson.
3. Singh B. D. (2015). *Biotechnology: Expanding Horizons*. Kalyani.
4. Dubey R. C. (2014). *Advanced Biotechnology*. S Chand & Co., New Delhi.
5. Pratibha Nallari and V. Venugopal Rao. (2010). *Medical Biotechnology*. Oxford University Press, USA.
6. Kumarsan, V. and N. Arumugam. (2016). *Fundamentals of Biotechnology*, Saras Publications, Nagercoil, Tamil Nadu.

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

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

**SKILL ENHANCEMENT COURSES:**

Semester	SEC – I	H/W	C
II	23PZOOS26 : POULTRY FARMING	4	2

**Course Objectives (CO):**

The main objectives of this course are:

1	To understand the various practices in Poultry farming.
2	To know the needs for Poultry farming and the status of India in global market.
3	To apply the techniques and practices needed for Poultry farming.
4	To know the challenges in Poultry farming

**UNIT - I:** General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming

**UNIT - II:** Management of chicks - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance

**UNIT - III:** Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.

**UNIT – IV:** Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.

**UNIT - V:** Selection, care and handling of hatching eggs - Egg testing. Methods of hatching.- Brooding and rearing -. Sexing of day-old chicks. - Farm and Water Hygiene - Recycling of poultry

**Expected Course Outcomes (CO)**

At the end of the course, the student will be able to

1	Understand the various practices in Poultry farming.
2	Know the status of Poultry farming.
3	Apply the techniques and practices needed for Poultry farming.
4	Know the difficulties in Poultry farming and be able to propose plans against it.

**Text Books:**

1. Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write & Print Publications, New Delhi 2.
2. Jull A. Morley, 2007. Successful Poultry Management. 2nd Edition. Biotech Books, New Delhi"
3. Hurd M. Louis, 2003. Modern Poultry Farming. 1st Edition. International Book Distributing Company, Lucknow."
4. Life and General Insurance Management"

**Reference Books:**

1. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.
2. <http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf>
3. [https://nsdcindia.org/sites/default/files/MC\\_AGR-Q4306\\_Small-poultry-farmer-.pdf](https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf)
4. <http://ecoursesonline.iasri.res.in/course/view.php?id=335>
5. [https://swayam.gov.in/nd2\\_nou19\\_ag09/preview](https://swayam.gov.in/nd2_nou19_ag09/preview)

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	1	1	1	1	1	3	3	1	1
CO2	3	1	2	2	3	2	2	2	3	3
CO3	3	2	2	2	3	3	3	3	2	2
CO4	3	3	3	1	3	3	3	3	3	3
CO5	3	3	2	3	3	3	2	1	3	2

\*

\*S - Strong; M - Medium; L – Low

## SECOND YEAR

<b>Core-VII</b>	<b>23PZOOC31: GENETICS</b>	<b>Credit</b>	<b>5</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>6</b>
<b>III Semester</b>			

### Learning Objective (LO):

<b>LO1</b>	Explain the organization and functions of genetic material in the living system.
<b>LO2</b>	Understand various sequential processes in protein synthesis
<b>LO3</b>	Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.
<b>LO4</b>	Able to distinguish lytic and lysogenic cycle and explain the mechanisms of genetic recombination of the microbes.
<b>LO5</b>	Understand the principle and application of rDNA technology for the welfare of human being.

**UNIT - I:** Structure, properties and functions of genetic materials: DNA as the genetic Materials - Basic structure of DNA and RNA, alternate and unusual forms of DNA - Physical and Chemical properties of nucleic acid, base properties, denaturation and renaturation, T<sub>m</sub> and cot values, hybridization.

**UNIT - II:** Genetic code - Methods of deciphering the genetic code and general features of the code word dictionary. Chromosomal genetics: Molecular structure of chromosomes - Variation in chromosome number and structure - Chromosome nomenclature - Chromosomal syndromes.

**UNIT - III:** Microbial Genetics: Genetics of Virus - Viral chromosome, Lytic cycle, Lysogenic cycle - Bacterial genetics -Bacterial genome - Gene transfer mechanisms in bacteria and virus - conjugation, transduction and transformation

**UNIT - IV:** Recombinant DNA technology: Recombinant DNA technology - Overview - Tools for Recombinant DNA Technology – Vectors - types - Techniques used in recombinant DNA technology - generation of DNA fragments - Restriction endonucleases, DNA modifying enzymes, Ligases

**UNIT - V:** Introduction of rDNA into host cell - calcium chloride mediated gene transfer - Agrobacterium mediated DNA transfer, electroporation, microinjection, liposome fusion, particle gun bombardment - Selection and screening of transformed cells - Expression of cloned gene; Application of rDNA technology in human welfare - Environment, Medicine and Agriculture



**Course Outcomes (CO)** At the end of the course, the student will be able to

<b>CO1</b>	Interpret phenotypic expressions based on genotype
<b>CO2</b>	Understand and interpret genetically linked diseases
<b>CO3</b>	Perform blood group analysis and test metabolic disorders
<b>CO4</b>	Working in clinical laboratories and take up researches

### TEXT BOOKS

1. Snustad, D.P. and M. J. Simmons. (2017). *Principles of Genetics*, John Wiley & Sons Inc., India.
2. Verma P. S. and V. K. Agarwal, (2015). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*, S. Chand and Company, New Delhi.
3. Jocelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick. (2015). *Lewins's Genes XI*, Jones and Bartlett Publishers, Inc., USA.
4. Karvita B. Aluwalia, (1991). *Genetics*, Wiley Eastern Ltd., New Delhi.
5. Robert H. Tamirin, (2004). *Principles of Genetics*, Tata McGraw-Hill Publishing Company Ltd. New Delhi.
6. Sarin, C., (1990). *Genetics*, Tata McGraw-Hill Publishing Co. Ltd, New Delhi.

### REFERENCE BOOKS

1. Gangane S. D. (2017). *Human Genetics*. Elsevier, India.
2. Robert Tamarin. (2017). *Principles of Genetics*. McGraw Hill, New York, USA.
3. James D. Watson, A. Baker Tania and P. Bell Stephen. (2017). *Molecular Biology of the Gene*. Pearson, UK.
4. Weaver, R.F. and P.W.Hedrick. (2015). *Genetics*, Brown (William C.) Co., U.S.
5. William S. Klug, Michael R. Cummings and Chariotte A. Spencer. (2016). *Concept of Genetics*. Pearson, UK.
6. Peter D. Snustad and Michael J. Simmons. (2011). *Genetics*. John Wiley & Sons, India.

### Outcome Mapping

Mapping with Programme Outcome3*										
CO3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	1	1	3	3	3	1	2	3
CO2	3	2	2	2	3	2	2	2	1	3
CO3	2	3	1	1	2	3	2	1	3	1
CO4	3	2	3	2	2	3	3	3	3	3
CO5	3	3	3	2	E	3	2	3	2	2

\*3 - Strong; 2 - Medium; 1 - Low

<b>Core-VIII</b>	<b>23PZOOC32: EVOLUTION</b>	<b>Credit</b>	<b>5</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>6</b>
<b>III Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	To understand the concept of evolution. It provides a comprehensive account of evidences to support concept of evolution and different theories for exploring the mechanism of evolution.
<b>LO2</b>	Study the origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.
<b>LO3</b>	Understand the major events in the evolutionary time scale; Origins of unicellular and multi-cellular organisms.
<b>LO4</b>	Comprehend the origin of new genes and proteins; Gene duplication and divergence.
<b>LO5</b>	Appreciate the concepts and rate of change in gene frequency through natural selection, migration and random genetic drift

**UNIT - I:** Emergence of evolutionary thoughts: Lamarck and Darwin – concepts of variation, adaptation, struggle, fitness and natural selection – Mendelism - Spontaneity of mutations - The evolutionary synthesis

**UNIT – II:** Origin of cells and unicellular evolution: Origin of basic biological molecules - Abiotic synthesis of organic monomers and polymers - Concept of Oparin and Haldane - Experiment of Miller (1953) - The first cell - Evolution of prokaryotes - Origin of eukaryotic cells - Evolution of unicellular eukaryotes - Anaerobic metabolism, photosynthesis and aerobic metabolism

**UNIT – III:** Paleontology and evolutionary history: The evolutionary time scale - Eras, periods and epoch - Major events in the evolutionary time scale - Origins of unicellular and multi cellular organisms - Stages in primitive evolution including *Homo sapiens*

**UNIT – IV:** Molecular evolution: Molecular divergence - Molecular tools in phylogeny, classification and identification - Protein and nucleotide sequence analysis - Origin of new genes and proteins - Gene duplication and divergence

**UNIT - V:** The mechanisms: Population genetics - Populations, Gene pool, Gene frequency - Hardy-Weinberg Law - concepts and rate of change in gene frequency through natural selection, migration and random genetic drift- Adaptive radiation - Isolating mechanisms – Speciation - Allopatricity and Sympatricity - Convergent evolution - Sexual selection - Co-evolution - Altruism and evolution

**Course Outcomes (CO)**

At the end of the course, the student will be able to

<b>CO1</b>	Analyse the evolutionary history of biological organisms
<b>CO2</b>	Critically assess the evolutionary relationship among various phyla
<b>CO3</b>	Identify the role of natural selection in the survival of the species
<b>CO4</b>	Understand the various mechanisms involved in evolution.

**Text book:**

1. Carl T. Bergstrom, and Lee Alan Dugatkin, (2016). *Evolution (Second Edition)*, W.W. Norton and company, New York, USA.
2. Hall, B.K. and B.Hallgrimson. (2014). *Strickbergers Evolution*, Jones and Bartlett Publishers Ltd., New Delhi.
3. Arumugam, N. (2014). *Organic Evolution*. Saras Publication. Nagercoil, Tamil Nadu.
4. Verma P. S. and V. K. Agarwal, (2015). *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology*, S. Chand and Company, New Delhi.
5. Verma P. S. and V. K. Agarwal, (2007). *Evolution*, S. Chand and Company, New Delhi.

**Reference:**

1. Darwin, C. The Origin of species, Te. Pup. Desmond Morris, (1990). *Animal Watching* (Field Guide), Crown Pup Co., London.
2. Dobzhansky, T. (1951), *Genetics and the origin of species*, Columbia University Press, USA.

**Outcome Mapping**

Mapping with Programme Outcomes*										
CO3	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	3	2	3	2	1	3	2	1	2
CO2	3	3	1	3	3	1	3	3	3	3
CO3	3	2	3	3	3	3	3	1	1	2
CO4	3	3	3	3	3	2	3	3	3	1
CO5	3	3	3	2	2	3	3	1	1	2

\*3 - Strong; 2 - Medium; 1 - Low

<b>Core-IX</b>	<b>23PZOOC33: ANIMAL PHYSIOLOGY</b>	<b>Credit</b>	<b>5</b>
<b>II Year</b>		<b>Hours/Week</b>	<b>6</b>
<b>III Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	Understand the functions of different systems of animals
<b>LO2</b>	Learn the comparative anatomy of heart structure and functions
<b>LO3</b>	Know the transport and exchange of gases, neural and chemical regulation of respiration
<b>LO4</b>	Acquire knowledge on the organization and structure of central and peripheral nervous systems

**UNIT - I:** Blood and circulation: Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis. Cardiovascular system : Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above

**UNIT - II:** Respiratory system: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration

**UNIT - III:** Nervous system: Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture. Sense organs: Vision, hearing and tactile response

**UNIT - IV:** Digestive system: Digestion, absorption, energy balance, BMR. Excretory system: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance

**UNIT - V:** Endocrinology and reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation. Thermoregulation: Comfort zone, body temperature- physical, chemical, neural regulation, acclimatization: Stress and adaptation

**Course Outcomes (CO)**

At the end of the course, the student will be able to

<b>CO1</b>	Understand the normal physiological functions and necessity to maintain a healthy Life
<b>CO2</b>	Get an opportunity to understand various factors that could lead to altered physiological functions and thereby health problems
<b>CO3</b>	Perform various physiological experiments and observations
<b>CO4</b>	Take up jobs in clinical labs and research institutes

**TEXT BOOKS**

1. Arumugam, N. and A. Mariakuttikan . (2017). Animal Physiology, Saras Publications, Nagercoil, Tamil Nadu.
2. Rastogi, S.C. (2016). Essentials of Animal Physiology, New Age International Publishers, New Delhi.
3. Verma, P. S., B. S. Tyagi and V. K. Agarwal, (2015). Animal Physiology. S. Chand & Company Ltd, New Delhi.
4. William S. Hoar, (1966). General and Comparative Physiology. Prentice Hall of India, New Delhi.
5. Wilson. A, (1979). Principles of Animal Physiology. Macmillan Publishing Co., Inc. New York.
6. Leon Goldstein, (1977). Introduction to Comparative Physiology. Holt, Rinehart and Winston, New York.
7. Prosser, L. and A. Brown, (1965). Comparative Physiology. Saunders Company, London.

**REFERENCE BOOKS**

1. Mohan P. Arora. (2018). Animal Physiology. Himalaya Publishing House Pvt. Ltd., New Delhi
2. Tomar B.S. and Neera Singh. (2016). Animal Physiology. Pragati Prakashan, Meerut, Uttar Pradesh.
3. Sobti R.C. (2011). Animal Physiology. Narosa Publishing House, New Delhi.
4. Sandeep Saxena. (2012). Animal Physiology. Oxford University Press, USA.
5. Arumugam N. (2014). Animal Physiology. Saras publications. Nagercoil, Tamil nadu

**Outcome Mapping**

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
<b>CO1</b>	2	3	2	3	2	1	3	2	3	3
<b>CO2</b>	3	3	2	3	3	3	3	2	3	3
<b>CO3</b>	3	2	3	3	3	2	1	3	2	3
<b>CO4</b>	3	3	3	3	3	1	2	3	3	2
<b>CO5</b>	3	3	3	2	2	2	2	1	1	2

\*3 - Strong; 2 - Medium; 1 – Low

<b>Core-X</b>	<b>23PZOOP34: PRACTICAL III - GENETICS, EVOLUTION AND ANIMAL PHYSIOLOGY</b>	<b>Credit</b>	<b>4</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>6</b>
<b>III Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	Acquire knowledge on various types genetics inheritance.
<b>LO2</b>	Learn the method of culturing of <i>Drosophila</i> and identification of their wild and mutant strains
<b>LO3</b>	Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities
<b>LO4</b>	Understand the animal evolution
<b>LO5</b>	Learn the various physiological processes

**Practical - Genetics**

1. Experiments on Mendelian inheritance
2. Experiments on polygenic inheritance
3. Human traits survey and data collection
4. Gene frequency calculations in population - Autosomal, multiple alleles and sex linked genes.
5. Testing the significance of genetic data - Chi-square test.
6. Human pedigree construction to study the inheritance of autosomal character.
7. Human pedigree for sex linked character and counseling
8. Culturing and maintenance of *Drosophila* in lab - Demonstration.
9. Identification of sex and mutant characters in *Drosophila*
10. Karyotyping of normal man using metaphase chromosomal plate.
11. Identification of human syndromes from karyotyping

**Practicals: Evolution**

1. Genetic drift in small and large population using dummy materials
2. Sexual selection(a) Secondary sexual characters, e.g. Chimeroïd fish (male), (b) Brooding organs- Sea Horse (male), (c) Special sound producing organs - scale insect (male), (d) Rhinoceros beetle (male).
3. Polymorphism- (a) Transient Polymorphism e.g. industrial melanism, (b) Neutral Polymorphism e.g. Umbonium shells, (c) Balanced Polymorphism
4. Genetic Assimilation – in *Drosophila*
5. Identification of male and female *Drosophila*
6. Mimicry and Colouration- Concealing mimicry, e.g. Kallima butterfly, Geometrid moth, Stick insect, Leaf insect.
7. Warning mimicry-Viceroy and Monarch butterfly, Batesian and Mullerian mimicry.

8. Paleontology: Invertebrate fossil - Trilobite, Vertebrate Fossil - Archaeopteryx.
9. Osteology: Evolution of reptilian skull and its interrelationship
10. Evolution of mankind- similarities and differences between apes and man. Evolution of human skull

### **PRACTICAL – Animal Physiology**

1. Effect of enzyme concentration on the activity of salivary amylase
2. Effect of substrate concentration on the activity of salivary amylase
3. Effect of pH concentration on the activity of salivary amylase
4. Oxygen consumption of fish.- Unit metabolism
5. Effect of thyroxin on the respiratory metabolism of fish.
6. Counting of blood cells (RBC and WBC).
7. Quantitative estimation of haemoglobin.
8. Quantitative estimation of proteins.
9. Biochemical analysis of protein, Carbohydrates and Lipids (Qualitative).

### **Outcome Mapping**

<b>Mapping with Programme Outcomes*</b>										
<b>CO3</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	2	3	2	3	2	1	3	2	3	3
<b>CO2</b>	3	3	2	3	3	3	3	2	3	3
<b>CO3</b>	3	2	3	3	3	2	1	3	2	3
<b>CO4</b>	3	3	3	3	3	1	2	3	3	2
<b>CO5</b>	3	3	3	2	2	2	2	1	1	2

\*3 - Strong; 2 - Medium; 1 - Low

<b>Elective - V</b>	<b>23PZOOE35-1 : Discipline Centric Elective – V</b>  <b>STEM CELL BIOLOGY</b>	<b>Credit</b>	<b>3</b>
<b>II Year</b>		<b>Hours/Week</b>	<b>3</b>
<b>III Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	To gain the basic knowledge of stem cells and their origin
<b>LO2</b>	To differentiate the embryonic and adult stem cells
<b>LO3</b>	To understand and apply the current stem cell therapies

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

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

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

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

**UNIT - V:** Current stem cell therapies: Advantages and disadvantages of ES cells and adult stem cells (MSCs and HSCs) therapy; Ethical concern on stem cell therapy; current stem cell therapy for various diseases; clinical outcome of stem cell therapy; state of clinical trials in adult stem cells for various diseases.



### Course Outcomes (CO)

At the end of the course, the student will be able to

<b>CO1</b>	Understand the basic knowledge of stem cells and their origin
<b>CO2</b>	Differentiating the embryonic and adult stem cells
<b>CO3</b>	Acquire knowledge on stem cells and aging
<b>CO4</b>	Understand and apply the current stem cell therapies for their research

### Text Books

1. Kiessling, A.A. 2006. Human Embryonic Stem Cells (Second Ed.), Jones & Barlett Publishers.
2. Lanza, R. and A. Atala. 2005. Essentials of Stem Cell Biology. Academic Press, pp-712.
3. Turksen, K. 2004. Adult Stem Cells. Humana Press, Inc, pp-429.
4. Lanza, R. *et al.* 2004. Handbook of Stem Cells: Embryonic/Adult and Fetal Stem Cells (Vol. 1 & 2). Academic Press, pp-1626.
5. Institute of Medicine, 2002. Stem cells and the future of regenerative medicine. National Academy Press, pp-112.
6. Marshak, D., R.L. Gardener and D. Gottlieb. 2001. Stem Cell Biology, Cold Spring Harbour Monograph Series, 40, pp-550.
7. Booth, C. 2003. Stem Cell Biology and Gene Therapy, Cell Biology International, Academic Press.

### Reference Books

1. Quesenberry, P.J., G.S. Stein, B. Forget and S. Weissman. 2001. Stem Cell Biology and Gene Therapy, Wiley Publishers, pp-584.
2. Sell, S. and Totowa, N.J. 2004. Stem Cells Handbook, Humana Press, pp-534.
3. Sullivan, S., C. A. Cowan and K. Eggan. 2007. Human Embryonic Stem Cells: The Practical Handbook, Wiley Publishers, pp-424.
4. Battler, A., and Leo, J. 2007. Stem Cell and Gene-Based Therapy: Frontiers in Regenerative Medicine, Springer Publication, pp-422.

### Outcome Mapping

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
<b>CO1</b>	2	3	2	3	2	3	2	3	2	2
<b>CO2</b>	3	3	2	3	3	3	3	3	3	1
<b>CO3</b>	3	2	3	3	3	3	2	1	3	2
<b>CO4</b>	3	3	3	3	3	2	2	3	1	2
<b>CO5</b>	3	3	3	2	2	3	3	3	3	3

\*3 - Strong; 2 - Medium; 1-Low

<b>Elective - V</b>	<b>23PZOOE35-2 : Discipline Centric Elective – V</b>  <b>ENDOCRINOLOGY</b>	<b>Credit</b>	<b>3</b>
<b>II Year</b>		<b>Hours/Week</b>	<b>3</b>
<b>III Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	To learn basics of various endocrine glands
<b>LO2</b>	To understand structure and functions of pituitary, thyroid and parathyroid gland
<b>LO3</b>	To understand the structure and functions of pancreas and adrenal glands

**UNIT - I: Pituitary Gland**

Pituitary gland – structural organization – anterior pituitary, Pars intermedia and neurohypophysis - Hypothalamic control of pituitary function.  
Pituitary hormones – functions of neurohormonal peptides - diuresis and antidiuresis.

**UNIT - II: Thyroid gland**

Thyroid gland – structural organization – Biosynthesis of thyroid hormones - biological functions of thyroid hormones – Thyroid dysfunction.

**UNIT - III: Parathyroid gland**

Parathyroid – structure and functions of parathyroid hormone – hormonal regulation of calcium and phosphorus metabolism.

**UNIT - IV: Pancreas**

Structure of pancreas – functions of insulin – Biosynthesis and regulation of the secretion of insulin – Biological action of insulin – function of glucagon – Biological action of glucagon.

**UNIT - V Adrenal glands**

Adrenals – structural organization - synthesis of adrenocortical hormones – Mineralocorticoids – Glucocorticoids - functions – regulation of cortisol secretion - abnormalities of adrenocortical secretions – hormones of adrenal medulla and their biological actions.

**Course Outcomes (CO)**

At the end of the course, the student will be able to

<b>CO1</b>	Understand the basics of various endocrine glands.
<b>CO2</b>	Pursue higher studies on endocrinology.
<b>CO3</b>	Take up jobs in clinical labs
<b>CO4</b>	Analyze biological samples of endocrinological importance

**TEXT BOOKS**

1. Shlomo Melmed , Kenneth S. Polonsky , P. Reed Larsen and Henry M. Kronenberg . (2017). *William's textbook of Endocrinology* , Elsevier India.
2. Handley, M.E. and J.E. Levine. (2017). *Endocrinology*, Pearson Education India.
3. Turner C. D. (1996). *General endocrinology*. 4<sup>th</sup> Ed, W.B. Saunders Co., London.
4. Bentley P. J. (1998). *Comparative Vertebrate Endocrinology*. Cambridge University Press, UK.
5. Barrington E. J. W., (1968). *An Introduction to General and Comparative Endocrinology*. Academic press, London.
6. Williams. R. H. (1974). *Text book of endocrinology*, 5<sup>th</sup>Ed. W B Souanders & co., Philadelphia, USA.

**REFERENCE BOOKS**

1. Pandey B.N. (2019). *Endocrinology*. Atlantic Publishers, Chennai, Tamil Nadu.
2. Jameson, J.L. (2016). *Harrison's Endocrinology*. McGraw Hill Education, New Delhi.
3. Lawrence I. Gilbert. (2011). *Insect Endocrinology*. Academic Press, USA.
4. Bruce A. White and Susan P. Porterfield (2013). *Endocrine and Reproductive Physiology*. Elsevier, India.
5. David, O. Norris and J.A.Carr. (2013). *Vertebrate Endocrinology*, Academic Press, USA.
6. Yadav B. N. (2011). *Mammalian Endocrinology*. Vishal Publishing Co., Punjab.

**Outcome Mapping**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	3	1	3	3	3	3	3
CO2	3	3	3	3	1	3	2	3	3	3
CO3	3	2	3	3	1	3	3	3	3	3
CO4	3	3	3	3	1	3	3	3	3	3

\*3 - Strong; 2 - Medium; 1-Low

<b>II Year</b>	<b>23PZOOS36: Skill Enhancement Course (SEC – II)</b>  <b>DAIRY FARMING</b>	<b>Credit</b>	<b>2</b>
<b>III Semester</b>			
<b>SEC: II</b>			

### Course Objectives

<b>1</b>	To understand the various practices in Dairy farming.
<b>2</b>	To know the status of Dairy farming.
<b>3</b>	To be able to apply the techniques and practices needed for Dairy farming.
<b>4</b>	To know the difficulties in Dairy farming.

**UNIT - I:** Introduction to Dairy Farming- Advantages of dairying- Classification of breeds of cattle-Indigenous and exotic breeds- Selection of dairy cattle. Breeding-artificial insemination-Dairy cattle management-General Anatomy.

**UNIT - II:** Construction of Model Dairy House - Types of Housing - Different Managerial Parameters - Winter Management - Summer Management

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

**UNIT – IV:** Composition of milk-milk spoilage-pasteurization - Milk and milk products in human nutrition – Dairying as a source of additional income and employment.

**UNIT – V:**Contagious disease - Common Bacterial - Protozoan - Helminth and Viral Diseases - Parasitic Infestation - Vaccination - Biosecurity.

**Course Outcomes (CO)**

At the end of the course, the student will be able to

<b>1</b>	Understand the various practices in Dairy farming.
<b>2</b>	Know the needs for Dairy farming and the status of India in global market.
<b>3</b>	Apply the techniques and practices needed for Dairy farming.
<b>4</b>	Know the difficulties in Dairy farming and be able to propose plans against it.

**Text Books**

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

**Reference Books**

1. [https://agritech.tnau.ac.in/farm\\_enterprises/Farm%20enterprises\\_%20Dairy%20unit.html](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>
3. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.
4. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley Inter Science, NewYork.

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

S - Strong; M - Medium; L – Low

Semester	23PZOOI37: SUMMER INTERNSHIP	H/W	C
III		-	2

(Refer to the Regulations)

<b>Core-XI</b>	<b>23PZOOC41: IMMUNOLOGY</b>	<b>Credit</b>	<b>4</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>5</b>
<b>IV Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	Various basic concepts in immunology and organization of immune systems.
<b>LO2</b>	Mechanisms of immune response in health and their defects in various diseases.
<b>LO3</b>	The application of immunological principles in biomedical sciences including blood transfusion, tissue grafting and organ transplantation.
<b>LO4</b>	Vaccinology and its importance in disease management
<b>LO5</b>	To gain knowledge regarding the application of immunological techniques

**UNIT - I:** Introduction to Immunology: An overview; Scope of immunology, recognition of self and non-self as a basic functional feature of immune system; Concepts of external and internal defence systems; External (first line / innate) defence system: components, distribution, salient functions; Internal (second line / acquired) immune system: cellular and humoral immune components- distribution, salient functions-primary and secondary immune responses; Immune tissues / organs: types, anatomical location, structure and development; lymphocyte traffic during development; Types of immunity: innate and acquired - types, functional features; concept of adaptive immunity

**UNIT - II:** Antigens: Definition, characteristic features and classification; Antigenicity versus immunogenicity; Adjuvants: definition, types and applications

**UNIT - III :** Major effector components of cellular immune system: Lymphocytes - types, morphology, clones; sub-populations, distribution, B and T cell receptors, B and T cell epitopes, Toll-like receptors; Antigen presenting cells: antigen processing and presentation, MHC molecules and their immunologic significance.

**UNIT - IV:** Major effector components of humoral immune system: Antibodies - Primary structure, classification, variants and antigen-antibody interactions; Structural and functional characteristics of various antibody classes; Generation of diversity; Monoclonal antibodies: definition, production and applications; Antibody engineering and its applications. Complement system - Components, three major activation pathways, and immune functions including anaphylaxis and inflammation. Cytokines - Definition and salient functional features; Interleukins: definition, types

(lymphokines and monokines), and functions. Interferons - Origin, types and functions

**UNIT - V** Diseases and immune responses: Hypersensitivity: definition, Types I to IV and immune manifestations; Auto-immune diseases: onset, spectrum of diseases, and major immune responses; Immunodeficiency diseases: types including SCID and consequences; Viral (HIV), bacterial (tuberculosis) and parasitic (malaria) diseases: etiology, host immune responses and evasion by pathogens; Vaccines: types, preparations, efficacies and recent developments

### Course Outcomes (CO)

At the end of the course, the student will be able to

<b>CO1</b>	Analyze the various immunological issues
<b>CO2</b>	Apply immunological procedures for various immunological testing procedures
<b>CO3</b>	Interpret the results of immunological experiments and take up jobs in clinical labs and related institution
<b>CO4</b>	Carry out immunological investigation and Equip themselves for higher studies

### TEXT BOOKS

1. Kannan, I. (2019). *Immunology*, MJP Publications, Chennai, Tamil Nadu.
2. Kinndt, T.J. Goldsby, R. A. and Osborne, B. A. ( 2007). *Immunology*, 6th Ed. W.H. Freeman and Company, New York.
3. Murphy, K.M. and C. Weaver. (2017). *Janeway's Immunology*, W. W. Norton & Company.
4. Nair, N.C., S.Leelavathy, N.Soundarapndian, T.Murugan an N.Arumugam. (2015). *A text book of Immunology*, Saras Publications, Nagercoil, Tamil Nadu.
5. Madhavee, L.P. (2012). *A text book of Immunology*, S. Chand and Co., New Delhi.
6. Rao. C.V. (2011). *Immunology*, A Text Book. 2<sup>nd</sup> Ed. Narosa Publishing House, New Delhi.

### REFERENCE BOOKS

1. Jenni Punt, Sharon Stranford, Patricia Jones and Judith A Owen. (2018). *Kuby Immunology*. W.H. Freeman, USA.
2. Ramesh S. R. (2017). *Immunology*. McGraw-Hill, New York, USA.
3. Abul K. Abbas, Andrew H. Lichtman and Shiv Pillai. (2017). *Cellular and Molecular Immunology*. Elsevier, India.
4. Peter J. Delves, Seamus J. Martin and Dennis R. Burton. (2017). *Roitt's Immunology (Essentials)*. Wiley Blackwell, UK.
5. Raj Khanna. (2011). *Immunology*. Oxford University Press, USA.



**Outcome Mapping**

<b>Mapping with Programme Outcomes*</b>										
<b>CO3</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	3	2	3	3	3	3	2	3	3	3
<b>CO2</b>	3	3	2	3	3	3	2	2	3	3
<b>CO3</b>	3	2	2	3	3	3	3	3	3	2
<b>CO4</b>	2	3	2	2	3	3	3	3	3	2
<b>CO5</b>	2	3	3	3	2	3	2	3	3	2

\*3 - Strong; 2 - Medium; 1 – Low

<b>Core-XII</b>	<b>23PZOOC42: ECOLOGY</b>	<b>Credit</b>	<b>4</b>
<b>II Year</b>		<b>Hours/Week</b>	<b>5</b>
<b>IV Semester</b>			

**Learning Objective (LO):**

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

**UNIT - I:** The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

**UNIT - II:** Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies ( $r$  and  $K$  selection); concept of metapopulation-demes and dispersal, interdemec extinctions, age structured populations -action taken to control population explosion.

**UNIT - III:** Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax.

**UNIT - IV:** Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory of island biogeography; bio-geographical zones of India.

**UNIT - V:** Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches - Waste management. Conservation biology: Principles of conservation, major

approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

### Course Outcomes (CO)

At the end of the course, the student will be able to

<b>CO1</b>	Analyse and appreciate the basic ecological concepts
<b>CO2</b>	Critically assess environmental disasters and suggest counter measures
<b>CO3</b>	Develop a mind set to safeguard natural resources and take forward the concept of sustainable development
<b>CO4</b>	Protect the environment by acting against pollution, take up employment in environment related agencies and institution and educate the public regarding the importance of rain water harvesting and water conservation

### Text books:

1. Arumugam, N. (2019). *Ecology & Toxicology*, Saras Publications, Nagercoil, Tamil Nadu.
2. Prabhat Patnaik and Jayanath Bhattacharjee, (2012). *Environmental Biodiversity*, Wisdom Press, New Delhi.
3. Khitoliya, R.K. (2004). *Environmental pollution: Management and control for sustainable developments*. S. Chand & company (p) Ltd., New Delhi, India
4. Saha, T. K. (2007). *Ecology and environmental Biology*. Books and allied (P) Ltd. Kolkata, India.

### Reference Books:

1. Krebs C. J. (2016). *Ecology: The experimental analysis of distribution and abundance*. Pearson India Education service (p) Ltd., New Delhi, India.
2. Arumugam A. and. Kumaresan V. (2016). *Environmental studies*. Saras Publication, Nagercoil, Tamil Nadu.
5. Mehta M (2010). *Understanding environmental science*. Discovery publishing house, New Delhi, India.
6. Pandey S.N. and S.P. Misra (2011). *Environment and ecology*. Ane Books Pvt. Ltd , New Delhi, India.
7. Agarwal K.C. (1999). *Environmental Biology*. Agro Botanica, New Delhi, India.

**Outcome Mapping**

<b>Mapping with Programme Outcomes*</b>										
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	3	3	2	2	3	2	3	3	2	3
<b>CO2</b>	3	3	2	2	1	3	3	3	2	2
<b>CO3</b>	3	2	2	1	2	3	1	1	3	1
<b>CO4</b>	2	2	3	3	2	1	1	3	3	3
<b>CO5</b>	2	3	3	2	3	2	1	2	1	3

\*3 - Strong; 2 - Medium; 1 – Low

<b>PRACTICAL - IV</b>	<b>23PZOOP43: LAB COURSE - PRACTICAL - IV IMMUNOLOGY AND ECOLOGY</b>	<b>Credit</b>	<b>2</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>2</b>
<b>IV Semester</b>			

**Course Objective :**

1	Acquire knowledge to differentiate the various immune cells
2	Understand antigen antibody interactions
3	Develop the analytical skill skills to know the nature of environment
4	Learn the method of analysis of water to know the pollution of it.

**Practical: IMMUNOLOGY**

1. Demonstration of lymphoid organs
2. Cell imprinting of lymphoid organs
3. Histology of lymphoid organs
4. Study of bone marrow cells
5. Identifications of leucocytes in human blood smear.
6. Differential count of W.B.C. from blood smear preparation
7. Human blood grouping
8. Antigen antibody interaction-Demonstration
9. Rapid plasma reagent (RpR) test for syphilis

**Practical: ECOLOGY**

1. Estimation of dissolved Oxygen content of water samples
2. Determination of Oxygen sag curve from river
3. Estimation of dissolved Carbon-Dioxide
4. Estimation of Hydrogen sulphide in water samples
5. Estimation of Residual chlorine in water samples
6. Estimation of total dissolved solids of water samples
7. Determination of sulphate in water samples
8. Determination of iron in water samples
9. Determination of silicate in water samples
10. Determination of nitrate/Nitrate in water samples

**Expected Course Outcome**

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

1	differentiate the various immune cells
2	Understand antigen antibody interactions
3	Develop the analytical skill skills to know the nature of environment

4	Learn the method of analysis of water to know the pollution of it.
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Mapping with Programme Outcomes										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	M	S	M	S	L	S	M	S	M	M
CO2	S	S	L	S	S	S	M	M	M	S
CO3	M	M	M	S	M	S	S	S	S	L
CO4	S	M	S	M	S	M	S	S	S	M
CO5	M	S	S	M	M	S	M	L	S	M

S - Strong; M - Medium; L-Low

	<b>23PZOOD44: PROJECT WITH VIVA-VOCE</b>	<b>Credit</b>	<b>7</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>10</b>
<b>IV Semester</b>			

**(Refer to the regulation for additional information)**

<b>Elective - VI</b>	<b>Elective – VI : Industry/ Entrepreneurship</b> <b>23PZOOE45-1: MEDICAL LABORATORY TECHNIQUES</b>	<b>Credit</b>	<b>3</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>4</b>
<b>IV Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.
<b>LO2</b>	Explain the characteristics of clinical samples and demonstrate skill in handling clinical equipment.
<b>LO3</b>	Evaluate the hematological and histological parameters of biological samples.

**Unit – I:** Laboratory safety - toxic chemicals and biohazards waste- biosafety level- good laboratory practice - hygiene and health issue - physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.

**Unit – II:** Composition of blood and their function- collection of blood & lab procedure- haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count WBC- blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.

**Unit – III:** Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome-Computer tomography (CT scan) - Magnetic Resonance imaging - flowcytometry - treadmill test - PET.

**Unit – IV:** Cardiovascular system- Blood pressure - Pulse - regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) - significance - ultra sonography- Electroencephalography (EEG).

**Unit – V:** Handling and labelling of histology specimens - Tissue processing - processing of histological tissues for paraffin embedding, block preparation. Microtomes – types of microtome- sectioning, staining - staining methods - vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques- freezing microtome.



**Text Books**

1. Godker, P. B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai.
2. Guyton and Hall, 2000. Text Book of medical Physiology, 10<sup>th</sup> edition, Elseiner, New Delhi.
3. Mukerjee, K.L, 1999. Medical Laboratory Technology- Vol, I, II, III. Tata MC GrawHill, New Delhi.
4. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation.

**Reference Books**

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

**Outcome Mapping**

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	2	2	2	1	1	2	2	1	2
CO2	3	3	2	3	3	3	1	2	3	3
CO3	2	3	3	3	3	3	3	3	3	1
CO4	3	3	2	2	1	2	1	2	2	3
CO5	2	2	3	3	2	3	1	1	3	3

\*3 - Strong; 2 - Medium; 1-Low

Elective - VI	Elective – VI: Industry/ Entrepreneurship  23PZOOE45-2 :AQUACULTURE AND THEIR BY-PRODUCTS	Credit	3
II Year		Hours/ Week	4
IV Semester			

**Learning Objective (LO):**

<b>LO1</b>	To develop knowledge on the fish farm and their maintenance. Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques
<b>LO2</b>	To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval rearing
<b>LO3</b>	To identify the different fish diseases, diagnosis and their management strategies. Understands Ornamental fishes and central aquaculture organizations

**Unit -1 Aquaculture**

Aquaculture - definition - scope and importance -status of aquaculture in India and world. Biology of Indigenous cultivable fishes (Catla, Rohu, Mrigal).

**Unit – 2 Types of Culture**

Different types of cultures, Monoculture, Poly culture. Composite fish culture, Cage culture , Pen culture, Race way culture - Extensive and intensive culture.

**Unit – 3 Ornamental fish culture**

Aquarium – Setting – requirements. Major aquarium fishes (Guppy, Gold fish, fighter fish, Gourami and Zebra fish) and their biology.

**Unit-4: Shell fish and sea weed culture**

Culture of fresh water prawn - *Macrobrachium rosenbergii*. Culture of brakishwater prawn *Litopenaeus vannamei*. Culture of pearl oyster (*Pinctada fucata*), green mussel (*Perna viridis*), lobster (*Panulirus homarus*). Culture of sea weed.

**Unit-5: Fishery by-products**

Fish preservation: Common principles of fish preservation and major methods of fish preservation. Fishery products and by products: Fish liver oil, fish body oil, fish meal, fish flour, fish silage, fish manure and guano, fish sausage, fish glue, isinglass, fish leather, fish macroni. Fish and prawn economics of aquaculture – Fish and prawn marketing.

**Course Outcomes (CO)**

At the end of the course, the student would have

<b>CO1</b>	Knowledge on the fish farm and their maintenance. Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques
<b>CO2</b>	To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval rearing
<b>CO3</b>	Identify the different fish diseases, diagnosis and their management strategies. Understands Ornamental fishes and central aquaculture organizations

**Text Books**

1. Pillay, T. V. R. (1990). Aquaculture: Principles and Practices. Blackwell Scientific Publications Ltd.
2. Santhanam, R. (1990). Fisheries Science. Daya Publishing House.
3. Sinha, V.R. P. and Srinivastava, H. C. (1991). Aquaculture Productivity. Oxford and IBH Publications CO., Ltd., New Delhi.
4. Yadav, B. N. (1997). Fish and fisheries. Daya Publishing house, New Delhi.

**Reference Books**

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

**Outcome Mapping**

<b>Mapping with Programme Outcomes*</b>										
<b>COs</b>	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>	<b>PO7</b>	<b>PO8</b>	<b>PO9</b>	<b>PO10</b>
<b>CO1</b>	3	3	2	2	3	3	3	2	2	3
<b>CO2</b>	3	3	3	2	3	3	3	2	3	3
<b>CO3</b>	3	3	3	3	3	3	3	3	3	2
<b>CO4</b>	3	3	2	3	3	3	3	2	2	3
<b>CO5</b>	3	3	2	3	2	3	2	1	3	3

\*3-Strong; 2-Medium; 1-Low

**SKILL ENHANCEMENT COURSE/ PROFESSIONAL COMPETENCY COURSE**

<b>Skill Enhancement Course</b>	<b>Skill Enhancement Course (SEC – II)</b>  <b>23PZOOS46: INTELLECTUAL PROPERTY RIGHTS</b>	<b>Credit</b>	<b>2</b>
<b>II Year</b>		<b>Hours/Week</b>	<b>4</b>
<b>IV Semester</b>			

**Learning Objective (LO):**

<b>LO1</b>	To know the importance of qualitative and quantitative information from biological data.
<b>LO2</b>	Able to claim the rights for the protection of their invention done in their project work.
<b>LO3</b>	To identify criteria to fit one's own intellectual work in particular form of IPRs
<b>LO4</b>	To get registration in our country and foreign countries of their invention, designs and thesis or theory written by students during their project.

**UNIT - I:** Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad - Genesis and Development - the way from WTO to WIPO - TRIPs, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations - Important examples of IPR.

**UNIT - II:** Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade secrets and Industrial Design registration in India and Abroad.

**UNIT - III:** International Treaties and Conventions on IPRs, TRIPs Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

**UNIT - IV:** Digital Innovations and Developments as Knowledge Assets - IP laws, Cyber law and Digital Content Protection - Unfair Competition - Meaning and Relationship between Unfair Competition and IP laws - Case studies.

**UNIT - V:** Infringement of IPRs, Enforcement Measures, Emerging issues - Case studies.

**Course Outcomes (CO)**

At the end of the course, the student will be able to

<b>CO1</b>	Claim the rights for the protection of their invention done in their project work.
<b>CO2</b>	Identify criteria to fit one's own intellectual work in particular form of IPRs
<b>COs</b>	To get registration in our country and foreign countries of their invention, designs and thesis or theory written by students during their project.
<b>CO4</b>	Acquire knowledge on IPR law, Cyber law and digital content protection

**Text Books**

1. Deborah E. Bouchoux, "Intellectual Property: The law of Trademarks, Copyrights, Patents and Trade secrets", Cengage learning, Third Edition, 2012.
2. Prabuddha Ganguli, "Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.
3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 201s

**Reference Books**

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

**Outcome Mapping**

Mapping with Programme Outcomes*										
COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
<b>CO1</b>	3	3	2	2	2	3	3	2	2	2
<b>CO2</b>	3	3	2	3	2	3	3	3	2	1
<b>CO3</b>	3	2	2	3	2	1	1	3	1	3
<b>CO4</b>	2	2	3	1	2	3	3	3	3	3
<b>CO5</b>	2	3	3	1	3	2	2	1	1	3

\*3 - Strong; 2 - Medium; 1 – Low

<b>Extension Activity</b>	<b>23PZOOX47 : EXTENSION ACTIVITY</b>	<b>Credit</b>	<b>1</b>
<b>II Year</b>		<b>Hours/ Week</b>	<b>-</b>
<b>IV Semester</b>			

**(Refer to the regulations)**