

**M.Sc ZOOLOGY**  
**Courses of study**  
**Schemes of Examinations & Syllabi**  
**For the students admitted in the year**  
**2023- 2024**



**PG & RESEARCH DEPARTMENT OF ZOOLOGY**  
**Bishop Heber College (Autonomous) (Nationally**  
**Reaccredited at the A+ level by NAAC)**  
**(Reaccredited with 'A' Grade (CGPA – 3.58/4.0) by the NAAC &**  
**College of Excellence by the UGC)**  
**TIRUCHIRAPPALLI – 620017**  
**TAMIL NADU, INDIA**

**TAMILNADU STATE COUNCIL FOR HIGHER EDUCATION,**  
**CHENNAI – 600 005**

**AUGUST- 2023**

## **Vision**

**Envisage quality higher education and research in the field of animal sciences with global perspectives by promoting discovery and learning contemporary fields in Zoology inculcating social values for the holistic development and to conserve nature thus contributing for nation building**

## **Mission**

- **Bestow quality education emphasizing the cognitive learning and concern towards the animal kingdom.**
- **Enrich field training skills, biodiversity conservation and entrepreneurship in the applied zoological sciences**
- **Enhance highest level of academic accomplishment with interdisciplinary approach through research, industrial collaboration and amalgamate with reputed national and international universities**
- **Foster globally competent individuals with interpersonal skills and environmental consciousness for the betterment of the world.**

<b>TANSICHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION</b>	
<b>Programme</b>	<b>M.Sc., Zoology</b>
<b>Programme Code</b>	
<b>Duration</b>	<b>PG-2 years</b>
<b>Programme Outcomes (Pos)</b>	<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></p> <p>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></p> <p>Ability to embrace moral/ethical values in conducting one's life.</p>
<p><b>Programme Specific Outcomes (PSOs)</b></p>	<p><b>PSO1 – Placement</b></p> <p>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></p> <p>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></p> <p>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></p> <p>To produce employable, ethical and innovative professionals to sustain in the dynamic business world.</p> <p><b>PSO 5 – Contribution to the Society</b></p> <p>To contribute to the development of the society by collaborating with stakeholders for mutual benefit.</p>

### Template for P.G., Programs

Semester-I	Credit	Hours	Semester-II	Credit	Hours	Semester-III	Credit	Hours	Semester-IV	Credit	Hours
1.1. Core-I	5	7	2.1. Core-IV	5	6	3.1. Core-VII	5	6	4.1. Core-XI	5	6
1.2 Core-II	5	7	2.2 Core-V	5	6	3.2 Core-VIII	5	6	4.2 Core-XII	5	6
1.3 Core - III	4	6	2.3 Core - VI	4	6	3.3 Core - IX	5	6	4.3 Project with viva voce	7	10
1.4 Discipline Centric Elective -I	3	5	2.4 Discipline Centric Elective - III	3	4	3.4 Core - X	4	6	4.4 Elective - VI (Industry / Entrepreneurship) 20% Theory 80% Practical	3	4
1.5 Generic Elective-II:	3	5	2.5 Generic Elective - IV:	3	4	3.5 Discipline Centric Elective - V	3	3	4.5 Skill Enhancement course / Professional Competency Skill	2	4
			2.6 NME I	2	4	3.6 NME II	2	3	4.6 Extension Activity	1	
						3.7 Internship/ Industrial Activity	2	-			

	<b>20</b>	<b>30</b>		<b>22</b>	<b>30</b>		<b>26</b>	<b>30</b>		<b>23</b>	<b>30</b>
<b>Total Credit Points -91</b>											

**Choice Based Credit System (CBCS) and Learning Outcomes Based Curriculum Framework (LOCF)**

**Programme : M.Sc. Zoology – 2023-2024**

Sem.	Part	Course	Course Title	Course Code	Hours / week	Credits	Marks		
							CI A	ES E	Total
I	Part A	Core Paper I	Structure and Function of Invertebrates	P23ZY101	7	5	25	75	100
		Core Paper II	Comparative anatomy of vertebrates	P23ZY102	7	5	25	75	100
		Core Practica I I	Invertebrates and Chordates Lab	P23ZY1P1	6	4	40	60	100
		Elective I	Molecules and their Interaction Relevant to Biology	P23ZY1:A	5	3	25	75	100
		Elective II	Biostatistics	P23ZY1:B	5	3	25	75	100
					30	20			
II	Part A	Core Paper III	Cellular and Molecular Biology	P23ZY203	6	5	25	75	100
		Core Paper IV	Developmental Biology	P23ZY204	6	5	25	75	100
		Core Practica I II	Cell Biology and Developmental Biology Lab	P23ZY2P2	6	4	40	60	100
		Elective III	Economic Entomology	P23ZY2:A	4	3	25	75	100
		Elective IV	Research Methodology	P23ZY2:B	4	3	25	75	100
		NMEC I	Aquarium Keeping	P23ZY2E1	4	2	25	75	100
					30	22			

III	Part A	Core Paper V	Genetics	P23ZY305	6	5	25	75	100	
		Core Paper VI	Evolution	P23ZY306	6	5	25	75	100	
		Core Paper VII	Animal Physiology	P23ZY307	6	5	25	75	100	
		Core Practica I III	Immunology, Animal Physiology and Biochemistry Lab	P23ZY3P3	6	4	40	60	100	
		Elective V	Stem Cell Biology	P23ZY3:A	3	3	25	75	100	
		NMEC II	Entrepreneurship in Zoology	P23ZY3E2	3	2	25	75	100	
		Internship	Internship / Industrial Activity	P23ZY3I1	--	2	100	--	100	
				30	26					
IV	Part A	Core Paper VIII	Immunology	P23ZY408	6	5	25	75	100	
		Core Paper IX	Ecology	P23ZY409	6	5	25	75	100	
		Core Project	Core Project with VivaVoce	P23ZY4PJ	8	7	40	60	100	
		Elective IV	Dairy and Poultry Farming	P23ZY4:A	4	3	25	75	100	
		SEC	IPR and Bioethics	P23ZY4S1	4	2	100	--	100	
		Extension Activity	Extension Activity	P23ETA41	--	1	--	--	--	
	Part B	VLO	The Big Picture	P23VLO41	2	2	100	--	100	
		Flying High	P23VLO42							
				<b>30</b>	25					
				<b>Total Credits :</b>		91	+2			



## SEMESTER I

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	To understand the concept of classification and their characteristic features of major group of invertebrates.	
<b>2.</b>	To realize the range of diversification of invertebrate animals.	
<b>3.</b>	To enable to find out the ancestors or derivatives of any taxon.	
<b>4.</b>	To know the functional morphology of system biology of invertebrates.	
<b>Course I</b>	<b>:</b>	<b>Core I</b>
<b>Course title</b>	<b>:</b>	<b>Structure and Function of Invertebrates</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <span style="float: right;"><b>COURSE CODE: P23ZY101</b></span>
<b>Pre-requisite:</b>		
Students should know the taxonomical classification of invertebrate animals in relation to their functional morphology.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, 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.	<b>K1 &amp; K2</b>
2.	Understand the evolutionary process. All are linked in a sequence of life patterns.	<b>K2 &amp; K4</b>
3.	Apply this for pre-professional work in agriculture and conservation of life forms.	<b>K3 &amp; K5</b>
4.	Analyze what lies beyond our present knowledge of life process.	<b>K4 &amp; K6</b>
5.	Evaluate and to create the perfect phylogenetic relationship in classification.	<b>K5 &amp; K6</b>
<b>K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 – Create</b>		
<b>Units</b>		
<b>I</b>	Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy	
<b>II</b>	Organization of coelom: Acoelomates; Pseudocoelomates; Coelomates: Protostomia and Deuterostomia; Locomotion: Flagella and ciliary movement in	

	Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata
<b>III</b>	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
<b>IV</b>	Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malphigian tubules; Mechanisms of excretion; Excretion and osmoregulation. Nervous system: Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda); Trends in neural evolution
<b>V</b>	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
<b>Reading list</b>	
1. Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.	
<b>Recommended texts</b>	
1. Barnes, R. D. 1974. Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition, pp-1024. 2. Barnes, R. S. K., P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. 2013. The Invertebrates: A Synthesis. Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi. 3. Dechenik, J. A. 2015. Biology of Invertebrates (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.	

<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>	S	S	M	S	S	S	M	S	S	S
<b>CO2</b>	S	S	M	M	S	S	M	M	S	S
<b>CO3</b>	S	M	S	M	S	S	M	M	S	S
<b>CO4</b>	S	M	S	M	S	S	M	M	S	M
<b>CO5</b>	S	M	S	M	S	S	M	M	S	M

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
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.	
<b>Course I</b>	<b>:</b>	<b>Core II</b>
<b>Course title</b>	<b>:</b>	<b>Comparative Anatomy of Vertebrates</b>
<b>Credits</b>	<b>:</b>	<b>4 COURSE CODE: P23ZY102</b>
<b>Pre-requisite:</b>		
Students with knowledge and comprehension on zoology.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, 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.	<b>K1 &amp; K2</b>
2.	Understand the evolutionary process. All are linked in a sequence of life patterns.	<b>K2 &amp; K4</b>
3.	Apply this for pre-professional work in agriculture and conservation of life forms.	<b>K3 &amp; K5</b>
4.	Analyze what lies beyond our present knowledge of life process.	<b>K4 &amp; K6</b>
5.	Evaluate and to create the perfect phylogenetic relationship in classification.	<b>K5 &amp; K6</b>

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

<b>Units</b>	
<b>I</b>	Origin of vertebrates: Concept of Protochordata; The nature of vertebrate morphology; Definition, scope and relation to other disciplines;
<b>II</b>	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.
<b>III</b>	General plan of circulation in various groups; Blood; Evolution of heart; Evolution of aortic arches and portal systems. Respiratory system: Internal and

	external respiration; Comparative account of respiratory organs
<b>IV</b>	Skeletal system: Form, function, body size and skeletal elements of the body; Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrate series.
<b>V</b>	Sense organs: Simple receptors; Organs of Olfaction and taste; Lateral line system; Electroreception. Nervous system: Comparative anatomy of the brain in relation to its functions; Nerves-Cranial, Peripheral and Autonomous nervous systems.
<b>Reading list</b>	
1. Swayam Prabha <a href="https://www.swayamprabha.gov.in/index.php/program/archive/9">https://www.swayamprabha.gov.in/index.php/program/archive/9</a>	
2. Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.	
3. Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.	
<b>Recommended texts</b>	
1. Waterman, A.J. 1972. Chordate Structure and Function, MacMillan Co., New York, pp.587.	
2. Parker T. J. and W. A. Haswell. 1962. A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750.	
3. Ekambaranatha Ayyar and T. N. Ananthakrishnan. 2009. Manual of Zoology, Vol – II, S. Viswanathan Pvt. Ltd. Chennai.	
4. Kotpal, 2019. R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut, pp-968.	

<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>	S	M	L	S	M	S	M	S	M	S
<b>CO2</b>	S	L	L	S	M	S	M	M	M	M
<b>CO3</b>	S	M	L	S	M	S	M	L	M	M
<b>CO4</b>	S	L	L	S	L	S	M	L	M	L
<b>CO5</b>	S	M	L	S	S	S	M	S	M	M

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
1.	Understanding the different systems in invertebrates & vertebrates.	
2.	Learning about various animal species, their phylogenetic affinities and their adaptive features	
3.	Imparting conceptual knowledge about the salient features and functional anatomy.	
4.	Developing the skill in mounting techniques of the biological samples.	
5.	Gaining fundamental knowledge on the skeletal system	
<b>Course I</b>	<b>:</b>	<b>Core Practical I</b>
<b>Course title</b>	<b>:</b>	<b>Lab Course in Invertebrates &amp; Chordates</b>
<b>Credits</b>	<b>:</b>	<b>4 COURSE CODE: P23ZY1P1</b>
<b>Pre-requisite:</b>		
Basic knowledge on the animals living in different habitats		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to:		
1.	Understand the structure and functions of various systems in animals	<b>K2 &amp; K4</b>
2.	Learn the adaptive features of different groups of animals	<b>K1 &amp; K2</b>
3.	Learn the mounting techniques	<b>K2 &amp; K3</b>
4.	Acquire strong knowledge on the animal skeletal system	<b>K2 &amp; K4</b>

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

## **INVERTEBRATES**

### **Dissection**

- Earthworm : Nervous system  
*Pila* : Digestive and nervous systems  
Cockroach : Nervous system  
Prawn : Appendages, nervous and digestive systems

**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 of Liver Fluke

7. *Tape worm (Scolex)*
8. *Ascaris T. S.*
9. Mysis of prawn

### **Spotters**

1. Scorpion
2. *Penaeus indicus*
3. *Emerita (Hippra)*

### **Mounting**

- Earthworm : Body setae  
*Pila* : Radula  
Cockroach : Mouth part

## **CHORDATES**

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

1. Nervous system of *Scoliodon laticaudatus* – 5<sup>th</sup> or Trigeminal nerve/  
Frog Virtual Dissection

### **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. *Exocoetus poecilopterus* (Flying fish)
8. *Mugil cephalus* (Mullet)
9. *Tilapia mossambicus* (Tilapia)
10. *Tetrodon punctatus* (Puffer fish)
11. *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.

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

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should know the fundamentals of biochemistry	
<b>Course I</b>	<b>:</b>	<b>Elective I</b>
<b>Course title</b>	<b>:</b>	<b>Molecules and their interaction relevant to Biology</b>
<b>Credits</b>	<b>:</b>	<b>3</b> <b>COURSE CODE: P23ZY1:A</b>
<b>Pre-requisite:</b>		
Understanding fundamental properties of elements, atoms, molecules, chemical bonds, linkages and structure, composition, metabolism and functions of biomolecules.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to:		
<b>I</b>	Learn the structure, properties, metabolism and bioenergetics of biomolecules	<b>K1 &amp; K3</b>
<b>II</b>	Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation	<b>K1 &amp; K2</b>
<b>III</b>	Understand the fundamentals of biophysical chemistry and biochemistry, importance and applications of methods in conforming the structure of biopolymers	<b>K2 &amp; K3</b>
<b>IV</b>	Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids	<b>K2 &amp; K4</b>
<b>V</b>	Familiarize the use of methods for the identification, characterization and conformation of biopolymer structures	<b>K5 &amp; K6</b>

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

<b>Units</b>	
<b>I</b>	Basics of biophysical chemistry and biochemistry: Structure of atoms, molecules and chemical bonds - Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
<b>II</b>	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).
<b>III</b>	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
<b>IV</b>	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).
V	Stabilizing interactions in biomolecules: Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage.
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>1. Berg, J. M., J. L. Tymoczko and L. Stryer 2002. Biochemistry. 5th Ed., W.H. Freeman &amp; Co., New York, pp-1050.</li> <li>2. Kuchel P.W. and G. B. Ralston. 2008. Biochemistry. McGraw Hill (India) Private Limited, UP, pp-580.</li> <li>3. McKee T. and J. R. McKee. 2012. Biochemistry: The Molecular Basis of Life. (7th Edition). Oxford University Press, US, pp-793.</li> <li>4. Nelson D.L. and M.M. Cox. 2012. Lehninger's Principles of Biochemistry. (6th Edition). W. H. Freeman Publishers, New York, pp-1158.</li> <li>5. Satyanarayana U. and U. Chakrapani, 2006. Biochemistry. (3rd Edition). Books and Allied (P) Ltd. Calcutta, pp-695.</li> </ol>	
<b>Recommended texts</b>	
<ol style="list-style-type: none"> <li>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.</li> <li>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.</li> <li>3. Palmer, T. 2004. Enzymes. Affiliated East-West Press Pvt. Ltd., New Delhi, pp-416.</li> <li>4. Voet D. and J.G. Voet. 2011. Biochemistry. (4th Edition). John Wiley &amp; Sons (Asia) Pvt. Ltd., pp-1428.</li> </ol>	

<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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should know basic concepts in Biostatistics.	
<b>Course I</b>	<b>:</b>	<b>Elective II</b>
<b>Course title</b>	<b>:</b>	<b>Biostatistics</b>
<b>Credits</b>	<b>:</b>	<b>3</b> <b>COURSE CODE: P23ZY1:B</b>
<b>Pre-requisite:</b>		
Students should be aware of importance of analysis of quantitative and qualitative information from biological studies.		
<b>Expected Course Outcome:</b>		
Upon completion of this course, Students would have		
<b>I</b>	Clear understanding of design and application of biostatistics relevant to experimental and population studies.	<b>K2 &amp; K3</b>
<b>II</b>	Acquired skills to perform various statistical analyses using modern statistical techniques and software.	<b>K3 &amp; K4</b>
<b>III</b>	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.	<b>K5 &amp; K6</b>

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

<b>Units</b>	
<b>I</b>	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.
<b>II</b>	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.
<b>III</b>	Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.
<b>IV</b>	Hypothesis testing: Student 't' test -Chi-square test-. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Regression analysis: Types and properties Computation of linear regression, calculation of regression co-efficient.
<b>V</b>	Analysis of variance: one way and two way classification. Data analysis with

	comprehensive statistical software using Statistical Package for the Social Sciences (SPSS).
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**Reading list**

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.

**Recommended texts**

1. Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467.
2. 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.
3. Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660.
4. Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.
5. Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp-593.
6. 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
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\*S - Strong; M - Medium; L- Low

## SEMESTER II

<b>Course Objectives:</b>		
The main objectives of this course are:		
1.	To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.	
2.	To realize involvement of various cellular components in accomplishing cell division.	
3.	To enable a successful performance in cell biology component of CSIR-UGC NET.	
4.	To understand the ultrastructures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.	
<b>Course I</b>	:	<b>Core III</b>
<b>Course title</b>	:	<b>Cellular and Molecular Biology</b>
<b>Credits</b>	:	<b>4</b> <span style="float: right;"><b>COURSE CODE: P23ZY203</b></span>
<b>Pre-requisite:</b>		
Students should have knowledge of the basic cellular structures and their salient functions in prokaryotic and eukaryotic cells.		
<b>Expected Course Outcome:</b>		
Upon completion of this course, students could		
1.	Understand the general concepts of cell and molecular biology.	<b>K2</b>
2.	Visualize the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance of molecular and cellular structures influencing functional features.	<b>K1 &amp; K2</b>
3.	Perceive the importance of physical and chemical signals at the molecular level resulting in modulation of response of cellular responses.	<b>K3 &amp; K4</b>
4.	Updated the knowledge on the rapid advances in cell and molecular biology for a better understanding of onset of various diseases including cancer.	<b>K5</b>
5.	Understand the general concepts of cell and molecular biology.	<b>K2</b>

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

<b>Units</b>	
<b>I</b>	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.

<b>II</b>	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, vacuoles
<b>III</b>	Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. PCD and its types, <b>Molecular biology of cell:</b> Structure of DNA and RNA; Process of DNA replication, transcription and translation in pro- and eukaryotic cells.
<b>IV</b>	Cell communication and cell signaling: Membrane- associated receptors for peptide and steroid hormones - signaling 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.
<b>V</b>	Cancer cells: Characteristic features of normal and cancer cells; Carcinogens: types and cancer induction; Metastasis; Oncogenes and tumor suppressor genes, therapeutic interventions of uncontrolled cell growth, apoptosis
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>1. Plopper, G., D. Sharp, and E. Sikorski. 2015. Lewin's Cells (Third Edition), Jones &amp; Bartlett, New Delhi, pp-1056</li> <li>2. Plopper, G. 2013. Principles of Cell Biology, Jones &amp; Bartlett, Maryland, pp-510</li> </ol>	
<b>Recommended texts</b>	
<ol style="list-style-type: none"> <li>1. Karp, G. 2010. Cell Biology (Sixth Edition), John Wiley &amp; Sons, Singapore, pp-765.</li> <li>2. Lodish, H., C. A. Kaiser, A. Bretscher, <i>et al.</i>, 2013. Molecular Cell Biology (Seventh Edition), Macmillan, England, pp-1154</li> <li>3. De Robertis, E.D.P. and E. M. F. De Robertis Jr, 1987. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734</li> <li>4. Abbas, A. K., A. H. Lichtman and S. Pillai, 2007, Cell and Molecular Immunology (Sixth Edition), Saunders, Philadelphia, pp-566</li> <li>5. Loewy, A.G., P. Siekevitz and J. R. Menninger, <i>et al.</i>, 1991, Cell Structure and Function (Third Edition), Saunders, Philadelphia, pp-947</li> <li>6. Alberts, B., A. Johnson, J. Lewis, <i>et al.</i>, 2015, Molecular Biology of the Cell (Sixth Edition), Garland Science, New York, pp-1342</li> <li>7. Clark, D.P., 2005. Molecular Biology, Elsevier, China, pp-784</li> <li>8. Tropp, B. 2008. Molecular Biology Genes to Proteins (Third Edition), Jones &amp; Bartlett, US, pp-1000</li> </ol>	

<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>	L	L	L	L	S	S	S	M	M	M
<b>CO2</b>	M	M	M	S	S	S	S	M	S	M
<b>CO3</b>	S	S	S	M	M	S	M	M	L	S
<b>CO4</b>	M	M	S	L	S	S	L	M	S	S

CO5	S	M	M	S	S	S	S	M	S	S
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\*S - Strong; M - Medium; L - Low

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Understand the process of gametogenesis, cleavage and gastrulation, embryonic development, extra embryonic membrane and placenta in various animals and human.	
<b>2.</b>	Learn the principles, methods and applications of cryo-preservation of gametes and embryo.	
<b>Course I</b>	<b>:</b>	<b>Core IV</b>
<b>Course title</b>	<b>:</b>	<b>Developmental Biology</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <b>COURSE CODE: P23ZY204</b>
<b>Pre-requisite:</b>		
Students have fundamental knowledge in developmental biology.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
<b>1.</b>	Define the concepts of embryonic development	<b>K1</b>
<b>2.</b>	Observe various stages of cell divisions under microscope	<b>K2 &amp; K3</b>
<b>3.</b>	Understand the formation of zygote	<b>K4</b>
<b>4.</b>	Differentiate the blastula and gastrula stages	<b>K4 &amp; K5</b>
<b>5.</b>	Learn the distinguishing features of three different germ layers and formation of various tissues and organs	<b>K4</b>

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

<b>Units</b>	
<b>I</b>	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;
<b>II</b>	Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitation in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg - Egg activation - Intracellular calcium release - Cortical reaction - Physiological polyspermy - Fusion of male and female pronuclei - Post fertilization metabolic activation – Parthenogenesis
<b>III</b>	Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition - Determinate and regulatory embryos, types of gastrulation in respective animal embryos (Mammals); Fate maps - (Amphibian and Chick), Epigenesis and preformation – Formation of primary germ layers
<b>IV</b>	Embryonic Development; Embryonic development of fish and birds, formation

	of extra embryonic membranes in mammalian – Organogenesis - Development of endodermal, mesodermal and ectodermal derivatives.; Formation and migration of neural crest cells - - primary and secondary neurulation. Gene and development; Anterior- posterior axis in determination in drosophila, Maternal effect genes - <i>Bicoid</i> and <i>Nanos</i> proteins; Generation of dorsal - ventral polarity- Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes
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 Salamander– 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,
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>Balinsky, B. I. 1981. Introduction to Embryology (5<sup>th</sup> Edition), CBS College Publishers, New York, pp-782.</li> <li>Gilbert. S. F. 2006. Developmental Biology, 8<sup>th</sup> Edition, INC Publishers, USA, pp-785.</li> <li>Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.</li> <li>Tyler, M.S. 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA, pp-208.</li> <li>Subramoniam, T. 2011. Molecular Developmental Biology (2<sup>nd</sup> Edition), Narosa Publishers, India, pp-364.</li> <li><a href="http://www.easybiologyclass.com">www.easybiologyclass.com</a> &gt; developmental-biology-e</li> <li><a href="http://www.studocu.com">www.studocu.com</a> &gt; document &gt; lecture-notes &gt; view</li> <li><a href="http://ocw.mit.edu">ocw.mit.edu</a> &gt; courses &gt; 7-22-developmental-biology-f.</li> </ol>	
<b>Recommended texts</b>	
<ol style="list-style-type: none"> <li>Wilt, F.H. and N.K. Wessel. 1967. Methods in Developmental Biology, Thomas Y Crowell, New York.</li> <li>Slack J.M.W. 2012. Essential Developmental Biology (3<sup>rd</sup> Edition), Wily-Blackwell Publications, USA, pp-496.</li> <li>Mari-Beffa, M. and J. Knight. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.</li> </ol>	

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

\*S - Strong; M - Medium; L – Low

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Practical course aims at demonstrating significant cellular and molecular biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology, genetics and developmental biology into practical understanding.	
<b>Course I</b>	<b>:</b>	<b>Core Practical II</b>
<b>Course title</b>	<b>:</b>	<b>Lab Course in Cell Biology and Developmental Biology</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <b>COURSE CODE: P23ZY2P2</b>
<b>Pre-requisite:</b>		
Students should have acquired basic knowledge relevant to this particular lab course.		
<b>Expected Course Outcome:</b>		
Upon completion of this lab course, students		
<b>1.</b>	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.	<b>K2</b>
<b>2.</b>	Understand and observe as well as correctly identify different cell types, cellular structures using different microscopic techniques.	<b>K3</b>
<b>3.</b>	Develop handling - skills through the wet-lab course.	<b>K6</b>
<b>4.</b>	Learn the method of culturing of <i>Drosophila</i> and identification of their wild and mutant strains	<b>K1 &amp; K2</b>
<b>5.</b>	Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities	<b>K1 &amp; K2</b>

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

### **CELL 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/Reproductive stages in mammals
4. Detection of polytene chromosome in salivary gland cells of the larvae of the Chironomus



5. Identification of blood cells in the haemolymph of the of the cockroach
6. Isolation of genomic DNA from eukaryotic tissue
7. Isolation of total RNA from animal cells/tissues
8. Agarose gel electrophoresis of DNA
9. SDS-Polyacrylamide gel electrophoresis
10. Western blotting technique (Demo)

### **DEVELOPMENTAL BIOLOGY**

Gametogenesis - Observation of gametes from gonadal tissue sections

- i. Oogenesis:
  - ✓ Section through ovary of fish / mammals
- ii Spermatogenesis:
  - ✓ Section through testis of fish / mammals

Fertilization

- v Observation of egg developmental stages in Fish

Embryogenesis

- vi Observation and whole mount preparation of the chick blastoderm
- 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
- xiv Demonstration of cryopreservation of gametes of fin fish/shell fish

<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>	S	M	S	S	S	S	S	L	L	M
<b>CO2</b>	S	S	S	S	S	M	M	M	M	M
<b>CO3</b>	S	S	M	S	S	L	S	M	L	M
<b>CO4</b>	M	M	L	M	L	M	M	S	M	L

CO5	S	S	M	L	S	M	L	S	S	S
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\*S - Strong; M - Medium; L – Low

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should acquire a fairly good understanding about the life of insects and their classification.	
<b>Course I</b>	<b>:</b>	<b>Elective III</b>
<b>Course title</b>	<b>:</b>	<b>Economic Entomology</b>
<b>Credits</b>	<b>:</b>	<b>3</b> <b>COURSE CODE: P23ZY2:A</b>
<b>Pre-requisite:</b>		
The students with a basic background in biological sciences with a special emphasis on the study of insects including systematic, beneficial insects, destructive insects, integrated pest management and insects of medical and veterinary importance.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
I	Understand taxonomy, classification and life of insects in the animal kingdom.	<b>K1 &amp; K2</b>
II	Know the life cycle, rearing and management of diseases of beneficial insects.	<b>K2 &amp; K3</b>
III	Know the type of harmful insects, life cycle, damage potential and management of pests including natural pest control	<b>K2 &amp; K3</b>
IV	Recognize insects which act as vectors causing diseases in animals and human.	<b>K2 &amp; K4</b>
	Overall understanding on the importance of insects in human life.	<b>K2 &amp; K6</b>

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

<b>Units</b>	
<b>I</b>	Overview of insects and insect taxonomy: Insects and their biological success - Man and insects; Basic concepts in Insect Taxonomy and classification.
<b>II</b>	Beneficial insects: Silkworms - types, life history, disease management and rearing methods - Types of honey bees, life history, social organization (colonies and caste system), honey bee care and management of bee hive - Lac insects-life history, lac cultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil-builders.
<b>III</b>	Destructive insects: Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Biology of the insect pests - Pests of paddy, cotton, sugarcane, vegetables, coconut and

	stored grains cereals.
<b>IV</b>	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.
<b>V</b>	Vector biology: Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>1. Ayyar, L.V. R. 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi, pp- 528.</li> <li>2. Vasantharaj David, B. and V.V. Ramamurthy. 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York, pp-400.</li> <li>3. Ross. H.H. 1965. A Text Book of Entomology, John Wiley &amp; Sons Inc., New York, pp-746.</li> </ol>	
<b>Recommended texts</b>	
<ol style="list-style-type: none"> <li>1. Chapman, R.F., S.J. Simpson and A.E. Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.</li> <li>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.</li> <li>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.</li> <li>4. Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.</li> <li>5. Krishnaswami, S. 1973. Sericulture Manual, Vol. I &amp; II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.</li> <li>6. Mani, M.S. 1982. General Entomology. Oxford &amp; IBH Publishing Co., pp-912.</li> <li>7. Wigglesworth, V.B. 1972. The Principles of Insect Physiology, ELBS &amp; Chapman and Hall, London, pp-827.</li> </ol>	

<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	M	M	S	L	M
<b>CO2</b>	S	S	M	S	S	S	S	S	S	L
<b>CO3</b>	S	M	S	S	S	S	S	S	S	S
<b>CO4</b>	S	S	S	S	S	S	M	S	M	M
<b>CO5</b>	S	S	S	M	M	S	M	L	S	M

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students understand the basic principle, methodology and applications of widely used instruments in biological sciences.	
<b>Course I</b>	<b>:</b>	<b>Elective IV</b>
<b>Course title</b>	<b>:</b>	<b>Research Methodology</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <b>COURSE CODE: P23ZY2:B</b>
<b>Pre-requisite:</b>		
Students should know the fundamentals of basic methods employed in experimental biology.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
<b>1.</b>	Understand the implications of GLP	<b>K1</b>
<b>2.</b>	Learn the working principles of different instruments	<b>K2</b>
<b>3.</b>	Gain the knowledge on techniques of histology and histochemistry	<b>K2 &amp; K4</b>
<b>4.</b>	Acquire knowledge on the basic principle and application of various modules of light and electron microscopy	<b>K3 &amp; K5</b>

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

<b>Units</b>	
<b>I</b>	Good laboratory practice (GLP) - pH, Electrodes and pH meter - Colorimeter and Spectrophotometry.
<b>II</b>	Histology, Histochemistry, Bioinformatics and Electron microscopy.
<b>III</b>	Light Microscopy, Bright field, Phase contrast, DIC & Fluorescence microscopy, wide field and Confocal microscopy.
<b>IV</b>	Centrifuges, Chromatography, Electrophoresis, ELISA and blotting.
<b>V</b>	Principles and Applications of tracer techniques in biology, Animal cell culture techniques.
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>1. Pearse, A.G. 1968. Histochemistry: Theoretical and Applied, Vol. I, Third Edition, J &amp; A Churchill Ltd, pp-758.</li> <li>2. Lillie, R.D. 1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715.</li> <li>3. Hoppert, M. 2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.</li> </ol>	
<b>Recommended texts</b>	
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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should develop entrepreneurship skills in Aquarium keeping	
<b>Course I</b>	:	<b>NMEC -I</b>
<b>Course title</b>	:	<b>Aquarium Keeping</b>
<b>Credits</b>	:	<b>2</b>
		<b>COURSE CODE: P23ZY2E1</b>

### Learning Objectives

- To create knowledge on self employment opportunity of ornamental fishes
- To provide the knowledge of ornamental fishes and their equipment
- To understand the different breeding techniques of ornamental fishes

#### UNIT I

Introduction and scope - Aquarium fish keeping as hobby and cottage industry. Commercial aspects like national and international market. To create knowledge on self employment opportunity.

#### UNIT II

External morphology of a typical fish. Exotic and endemic varieties of ornamental fishes.

#### UNIT III

Aquarium preparation and maintenance - Kinds of tanks, tank setting, biological filter and aeration, water management, planting, lighting and feeds. Budget for setting up an Aquarium Fish Farm as a Cottage Industry

#### UNIT IV

Live fish transport- handling, feeding and forwarding techniques of fish. Fish Diseases and their control.

#### UNIT V

Breeding – Common characters and sexual dimorphism of Fresh water and Marine aquarium ornamental fish varieties such as Guppies, Mollies, Sword tails, Platy, Siamese fighters and Gold fish, Butterfly fish, Blue morph and Anemone fish.

#### REFERENCE BOOKS:

1. Santhanam, P., Sukumaran, N. & P. Natarajan, A manual of freshwater aquaculture (1987), Reprint 1999, Oxford & IBH Publishing Company Pvt., Ltd., New Delhi.
2. Cliff Harrison, A colour guide to Tropical Fish (1980), Chartwell Books, INC, Cerkshire, printed in Hon Kong.
3. O'Connell, R. F., The freshwater aquarium (1977), Arco Publishing Company, INC New York.
4. Jingran V.G., 1991: Fish and Fisheries in India – Hindustan Publ.co. New Delhi
5. Mill Dick, 1993: Aquarium Fish, Daya Pub.co., New Delhi

#### Course Outcome:

- Students to learn about different ornamental fishes and identify the diseases of them

- To develop entrepreneur potential in the field of aquarium and get self employment.

### SEMESTER III

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Understanding DNA as genetic material, fine structure of DNA & RNA molecules, as well as physico-chemical properties of macromolecules.	
<b>2.</b>	Gain insight into sequential events occurs during protein synthesis.	
<b>3.</b>	Learn the structure and function of chromosome and chromosomal basis of genetic disorders.	
<b>4.</b>	To acquire knowledge about microbial genetics	
<b>5.</b>	To provide information about rDNA technology and its application.	
<b>Course I</b>	<b>:</b>	<b>Core V</b>
<b>Course title</b>	<b>:</b>	<b>Genetics</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <span style="float: right;"><b>COURSE CODE: P23ZY305</b></span>
<b>Pre-requisite:</b>		
Basic knowledge on molecular biology and genetics		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
<b>1.</b>	Explain the organization and functions of genetic material in the living system.	<b>K1 &amp; K2</b>
<b>2.</b>	Understand various sequential processes in protein synthesis	<b>K1 &amp; K2</b>
<b>3.</b>	Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.	<b>K2 &amp; K4</b>
<b>4.</b>	Able to distinguish lytic and lysogenic cycle and explain the mechanisms of genetic recombination of the microbes.	<b>K2 &amp; K5</b>
<b>5.</b>	Understand the principle and application of rDNA technology for the welfare of human being.	<b>K2 &amp; K3</b>

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

<b>Units</b>	
<b>I</b>	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.
<b>II</b>	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.
<b>III</b>	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
<b>IV</b>	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
<b>V</b>	Introduction of rDNA into host cell - calcium chloride mediated gene transfer - <i>Agrobacterium</i> 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

#### Reading list

1. Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley & Sons. INC. New York, pp-740.
2. Brooker, R. J. 2014. Genetics: Analysis and Principles. 5th Edition, McGraw Hill Publisher, pp-880.
3. Russell, P.J. 2005. Genetics: A Molecular Approach (2nd Edition). Pearson/Benjamin Cummings, San Francisco, pp-850.
4. [https://onlinecourses.swayam2.ac.in/cec21\\_bt02/preview](https://onlinecourses.swayam2.ac.in/cec21_bt02/preview)
5. <https://www.khanacademy.org/science/high-school-biology/hs-molecular-genetics/hs-rna-and-protein-synthesis/a/the-genetic-code>

#### Recommended texts

1. Griffiths, A. J. F., H. J. Muller, D. T. Suzuki, R. C. Lewontin and W. M. Gelbart. 2012. An Introduction to Genetic Analysis. 11th Edition, W. H. Greeman. New York.
2. Snustad, D.P., Simmons, M.J. 2015. Principles of Genetics, John Wiley Publications, pp-784.
3. Watson, J. D., T. A. Baker, S. P. Bell, Alexander Gann, Michael Levine, Richard Losick. 2003. Molecular Biology of the Gene, (5<sup>th</sup> Edition). Cold Spring Harbor Laboratory Press, pp-912.
4. Klug, W. S. and M. R. Cummings, C. A. Spencer. 2005. Concepts of Genetics, Benjamin - Cummings Publishing Company.
5. Harti, D. L. 2002. Essential Genetics, A Genomic Perspective, Jones & Bartlet.
6. Krebs, J. E., E.S. Goldstein, S.T. Kilpatrick. 2018. Lewin's Genes XII, Jones & Bartlet Publisher, pp-613.
7. Watson, J. D., T. A. Baker S. P. Bell, A. Cann, M. Levine and R. Losick, 2014. Molecular Biology of Gene 7th Edition, Pearson Education RH Ltd. India.

#### Mapping with Programme Outcomes\*

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



CO5	S	S	S	M	E	S	M	S	M	M
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\*S - Strong; M - Medium; L - Low

<b>Course Objectives:</b>		
The main objectives of this course are:		
1.	To critically analyze the concepts of evolution in order to	
2.	Understand the factors responsible for origin and generation of diversity among living beings and	
3.	To develop strategies for sustenance of life on this planet	
4.	To critically analyze the concepts of evolution in order to	
<b>Course I</b>	:	<b>Core VI</b>
<b>Course title</b>	:	<b>Evolution</b>
<b>Credits</b>	:	<b>4</b> <b>COURSE CODE: P23ZY306</b>
<b>Pre-requisite:</b>		
Students shall have basic knowledge on the diversity of animals, biology including morphological, anatomical, physiological and embryological features of various phyla and their environment.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
1.	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>K1 &amp; K3</b>
2.	Study the origin of eukaryotic cells; Evolution of unicellular eukaryotes; Anaerobic metabolism, photosynthesis and aerobic metabolism.	<b>K1 &amp; K2</b>
3.	Understand the major events in the evolutionary time scale; Origins of unicellular and multi-cellular organisms.	<b>K2 &amp; K3</b>
4.	Comprehend the origin of new genes and proteins; Gene duplication and divergence.	<b>K2 &amp; K4</b>
5.	Appreciate the concepts and rate of change in gene frequency through natural selection, migration and random genetic drift	<b>K4 &amp; K5</b>

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

<b>Units</b>	
<b>I</b>	Emergence of evolutionary thoughts: Lamarck and Darwin – concepts of variation, adaptation, struggle, fitness and natural selection – Mendelism - Spontaneity of mutations - The evolutionary synthesis
<b>II</b>	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
<b>III</b>	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 <i>Homo sapiens</i>
<b>IV</b>	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
<b>V</b>	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

### Reading list

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

### Recommended texts

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

### Mapping with Programme Outcomes\*

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

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students acquire the basic knowledge on physiology of different organs in animals and human.	
<b>2.</b>	Understand the functions of different systems such as digestion, excretion, blood circulatory system, respiration and nervous system of animal relating them to structure and functions of various organs.	
<b>Course I</b>	<b>:</b>	<b>Core VII</b>
<b>Course title</b>	<b>:</b>	<b>Animal Physiology</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <b>COURSE CODE: P23ZY307</b>
<b>Pre-requisite:</b>		
Students should know the fundamentals of structure and functions of organs and organ systems of animals.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
<b>1.</b>	Understand the functions of different systems of animals	<b>K1</b>
<b>2.</b>	Learn the comparative anatomy of heart structure and functions	<b>K2</b>
<b>3.</b>	Know the transport and exchange of gases, neural and chemical regulation of respiration	<b>K2 &amp; K4</b>
<b>4.</b>	Acquire knowledge on the organization and structure of central and peripheral nervous systems	<b>K3 &amp; K5</b>

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

<b>Units</b>	
<b>I</b>	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
<b>II</b>	Respiratory system: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration
<b>III</b>	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
<b>IV</b>	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
<b>V</b>	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

### Reading list

1. Prosser C. L. 1991, Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley-Liss Publishers, pp-592
2. Hoar, S.W. 1983, General and Comparative Physiology, Prentice Hall Publication, pp-928.
3. Randall, D., W. Burggren, K. French and R. Eckert. 2001, Animal Physiology Mechanisms and Adaptations, New York : W.H. Freeman and Co., pp-
4. Nelson K. S. 1997. Animal Physiology: Adaptation and Environment, Cambridge University Press, pp- 617.
5. Dantzler, W.H. 1997. Comparative Physiology (Handbook of Physiology), Volumes I and II. Edited by William H. Dantzler. pp - 1824 Published for the American Physiological Society by Oxford University Press Inc., New York. Oxford University Press Canada, Toronto.
6. [https://swayam.gov.in/nd1\\_noc20\\_bt42/preview](https://swayam.gov.in/nd1_noc20_bt42/preview)
7. <https://www.classcentral.com/course/swayam-animal-physiology-12894>
8. [https://swayam.gov.in/nd1\\_noc20\\_hs33/preview](https://swayam.gov.in/nd1_noc20_hs33/preview)

### Recommended texts

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

### Mapping with Programme Outcomes\*

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

<b>CO2</b>	S	S	M	S	S	S	S	M	S	S
<b>CO3</b>	S	M	S	S	S	M	L	S	M	S
<b>CO4</b>	S	S	S	S	S	L	M	S	S	M
<b>CO5</b>	S	S	S	M	M	M	M	L	L	M

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	To provide hands-on training to perform specific lab courses in immunology and research methodology.	
<b>2.</b>	To enable clear understanding of the methodology through wet – lab courses.	
<b>Course I</b>	<b>:</b>	<b>Core Practical III</b>
<b>Course title</b>	<b>:</b>	<b>Lab Course in Immunology</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <b>COURSE CODE:P23ZY3P3</b>
<b>Pre-requisite:</b>		
Students should acquire the basic knowledge relevant to a particular lab course.		
<b>Expected Course Outcome:</b>		
Upon completion of this lab course, the students		
<b>1.</b>	Acquire ability to perform/ demonstrate various basic concepts in immunology as well as applications of research methods for quantitative/ qualitative analysis of biochemical components.	<b>K3 &amp; K4</b>

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

1. Identification of various immune tissues and organs in rat
2. Identification of various types of immune cells in peripheral blood smear
3. Separation of RBC as intact cellular antigen for immunization
4. Antigenic challenge of mammalian hosts through different routes, and comparative evaluation of their merits and demerits
5. Methods of blood sampling
6. Preparation and storage of antiserum
7. Agglutination reaction: Qualitative analysis of antigen-antibody reaction using human blood group system
8. Agglutination reactions: Determination of hemagglutination titer of IgM antibodies using human RBC
9. Detection of IgG by precipitation ring test

10. Detection of IgG by Ouchterlony double immuno-diffusion test
11. Detection of reactivity of IgG with fractionated antigens by immune - electrophoresis
12. Separation of lymphocytes from peripheral blood and identification of T and B cell

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should know understand the basics of stem cells	
<b>Course I</b>	<b>:</b>	<b>Elective V</b>
<b>Course title</b>	<b>:</b>	<b>Stem cell biology</b>
<b>Credits</b>	<b>:</b>	<b>3</b> <b>COURSE CODE:P23ZY3:A</b>
<b>Pre-requisite:</b>		
Students should understand the basics of stem cells and its applications		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
<b>I</b>	Understand the basic knowledge of stem cells and their origin	<b>K1 &amp; K2</b>
<b>II</b>	Differentiating the embryonic and adult stem cells	<b>K3 &amp; K4</b>
<b>III</b>	Understand and apply the current stem cell therapies for their research	<b>K5</b>

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

<b>Units</b>	
<b>I</b>	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).
<b>II</b>	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).
<b>III</b>	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.
<b>IV</b>	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.
<b>V</b>	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.

### Reading list

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.

### Recommended texts

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.

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

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should gain knowledge in Entrepreneurship in Zoology	
<b>Course I</b>	:	<b>NMEC-2</b>
<b>Course title</b>	:	<b>Entrepreneurship in Zoology</b>
<b>Credits</b>	:	<b>2</b>
		<b>Course Code: P23ZY3E2</b>

### Learning Objective

1. To understand the culturing techniques and production methods of different farm animals.
2. To know the life history of animals and disease control methods used in farming.
3. To understand the concept of breeding, cross breeding and the importance of high yield varieties.
4. To know about the marketing strategies.

**Unit I: Economic Entomology** : Apiculture: Species of honey bees – Social organisation of honey bee – selection of bees and location for apiary – Newton’s bee hive – products of bee keeping – enemies and diseases of honey bees. Sericulture: Species of silkworm – life history of mulberry silkworm – Rearing of silkworm – pests and diseases of silkworm.

Lac Culture: Introduction – Life history – Host plants – cultivation of Lac – Enemies of lac cultivation – Economic importance of Lac.

**Unit II: Vermiculture** : Introduction: Types of earthworms – ecological classifications of earthworms – Physical, chemical and biological changes caused by earthworms in the soil – Natural enemies of earthworms. Vermicomposting: vermicomposting methods – factors affecting vermicomposting –Vermiculture unit. Harvesting of vermicompost – vermicast – advantages of vermicompost – vermiwash and its applications.

**Unit III: Aquaculture** : Fresh water aquaculture: Carp culture – types of ponds – preparation – maintenance – harvesting and management. Integrated and composite culture. Prawn culture. Marine Aquaculture: Edible – pearl oyster culture. Ornamental fish culture: Aquarium fishes – Aquarium maintenance in home.

**Unit IV: Poultry Farming** : Poultry industry in India – Poultry for sustainable food production and livelihood - Commercial poultry farming – Nutritive value of egg and meat- Broiler management (Definition; Housing and equipment; Brooding, feeding and health cover of broilers; Record keeping; Broiler integration) – Layer management (Brooder; Grower and layer management; Culling of layers; Marketing of eggs and meat). Women in backyard poultry farming.

**Unit V: Dairy Farming** : Dairy farming – advantages of dairying – classification of breeds of cattle – Indigenous and exotic breeds – Selection of dairy cattle. Breeding – artificial insemination – Dairy cattle management – housing – water supply – cattle nutrition feeding



standards – Common contagious diseases. Milk - Composition of milk – milk spoilage – pasteurization – Role of milk and milk products in human nutrition – Dairying as a source of additional income and employment.

### **Text Books**

1. Sastry, N.S.R., C.K.Thomas and R.A.Singh, 2015. Livestock Production Management, 4<sup>th</sup>Ed.Kalyani Publishers, New Delhi.
- Mary violet Christy, A. 2014. Vermitechnology, MJP Publishers, Chennai.
2. ICAR, 2013. Hand book of Animal Husbandry, 4<sup>th</sup> Ed., ICAR Publication, Pusa, New Delhi.
3. Awasthi, V.B., 2012. Introduction to General and Applied Entomology, third edition, Scientific publishers, India.
4. Vasanthraj David, B and Ramamurthy, VV., 2012. Elements of Economic Entomology, Seventh edition, Namrutha publications, Chennai.
5. Shukla &Upadhyay, 2014. Economic Zoology, 5<sup>th</sup> edn. Rastogi Publication, Meerut New Delhi.
6. Gupta, S.M., 2010. Text book of fishery, Ann Backer, Mumbai.
7. ShailendraGhosh, 2009. Fisheries and aquaculture management, Adhyayan, New Delhi.
8. David, B and Ananthkrishnan, T. N., 2006. General and Applied Entomology, Second edition, Tata McGraw hill publishing company Ltd., New Delhi, India.
9. Jagadish Prasad, 2002. Principles and practices of Dairy Farm Management, 3<sup>rd</sup> Ed. Kalyani Publishers, Ludhiana.
10. Sukumar, D.E., 2002. Outline of Dairy Technology, Oxford University, New Delhi.
11. Rath, R.K., 2000. Freshwater Aquaculture. Scientific Publishers (India), Jodhpur.
12. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.
13. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai.
14. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea & Fabiger Publisher.

### **Suggested Readings**

1. Glenn Munroe, 2017. Manual of on-Farm vermicomposting and vermiculture, Holdanca Farms Ltd, Wallace, Nova Scotia.
2. Hanifa, M.A., 2011. Aquatic resources and aquaculture, Dominent, New Delhi.
3. Gupta, P.K., 2008. Vermicomposting for sustainable agriculture, 2<sup>nd</sup> Edition, Agrobios, India.
4. Talashikar, S.C., 2008. Earthworms in Agriculture, Agrobios, India.
5. Abishek Shukla, D ., 2009. A Hand Book of Economic Entomology, Vedamse Books, New Delhi .

6. Banerjee, G.C., 2006. Text book of Animal Husbandry 8<sup>th</sup>Ed.Oxford and IBH Publishing Company Ltd., New Delhi.
7. Walstra, P. Wouters, J.T.M. and Geurts, T.J. 2006. Dairy Science and Technology. CRC Press, New York.
8. Dunham, R.A., 2004. Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications, U.K.
9. Donald.D Bell and William. D. Weaver, 2002. Commercial chicken meat and egg production, Springer, New York.
- 10.Eckles C.H. and Anthony, E.L., 2001. Dairy Cattle and milk production, Biotech. Tata McGraw Hill Publishing Co.Pvt.Ltd., New Delhi.
- 11.Edwards, C.A., and Bother, B., 1996. Biology of earthworms, Chapman Hall Publication company.
- 12.ICAR, 1997. Handbook of Animal Husbandary– The Indian Council of Agricultural Research, New Delhi.
- 13.Banerjee G.C., 1992. Poultry, Oxford and IBH, New Delhi.
- 14.Jhingran, AVG, 1991. Fish and Fisheries of India. Hindustan Publishing Co. New Delhi.
- 15.James. N. Marnar, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.
- 16.Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, NewYork.

#### **Web Resources**

1. <https://bit.ly/3tXHjk8>
2. <https://bit.ly/3tUTHBu>
3. <https://bit.ly/3hVv96q>
4. <https://bit.ly/39nztH1>
5. <https://bit.ly/3CzasVO>
6. [https://agritech.tnau.ac.in/org\\_farm/orgfarm\\_vermicompost.html](https://agritech.tnau.ac.in/org_farm/orgfarm_vermicompost.html)
7. <https://bit.ly/3nYvgSF>
8. <http://caa.gov.in/farms.html>
9. <http://www.csrtimys.res.in/>
10. <http://www.agshoney.com/training.htm>

#### **Course Outcomes (COs)**

1. To identify the breeds and varieties of poultry, fish, bees, and cattle and understand the basic aspects of farming.
2. To assess and integrate the available tools and techniques to increase the productivity in farms.
3. To analyse the pros and cons of different methods of farming and marketing strategies of products.

4. To evaluate the use of available resources in improving the breeds, vermicomposting, farm products etc..
5. To design new methods to improve farm animals with increased productivity and disease resistance and to construct new methods in vermicomposting.

<b>Course</b>	<b>:</b>	<b>INTERNSHIP/INDUSTRIAL ACTIVITY</b>
<b>Course title</b>	<b>:</b>	
<b>Credits</b>	<b>:</b>	<b>4</b> <b>COURSE CODE: P23ZY3I1</b>

### SEMESTER - IV

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	To impart conceptual understanding of functional organization of immune system and its responsiveness in health and disease.	
<b>2.</b>	To enable a successful performance in Immunology component of CSIR-UGC NET.	
<b>Course I</b>	<b>:</b>	<b>Core VIII</b>
<b>Course title</b>	<b>:</b>	<b>Immunology</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <span style="float: right;"><b>COURSE CODE:P23ZY408</b></span>
<b>Pre-requisite:</b>		
Students would have basic knowledge in animal science, particularly functional anatomy, cell biology and developmental biology.		
<b>Expected Course Outcome:</b>		
Students would have acquired clear knowledge on		
<b>1.</b>	Various basic concepts in immunology and organization of immune systems.	K2
<b>2.</b>	Mechanisms of immune response in health and their defects in various diseases.	K2 & K4
<b>3.</b>	The application of immunological principles in biomedical sciences including blood transfusion, tissue grafting and organ transplantation.	K3 & K5
<b>4.</b>	Vaccinology and its importance in disease management	K3

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

<b>Units</b>	
<b>I</b>	Introduction to Immunology: An overview; Scope of immunology, Concepts of external and internal defense systems; External (first line / innate) defense 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;
<b>II</b>	Antigens: Definition, characteristic features and classification; Antigenicity versus immunogenicity; Adjuvants: definition, types and applications. Immunology of Cancer: Tumor antigens- Immuno therapy
<b>III</b>	Major effector components of cellular immune system: Lymphocytes - types, morphology, clones;, 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
<b>IV</b>	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
<b>V</b>	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), etiology, host immune responses and evasion by pathogens; Vaccines: types, preparations, efficacies and recent developments
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>1. Kuby, J. 1997. Immunology. W. H. Freeman &amp; Co., New York, pp-670.</li> <li>2. Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7<sup>th</sup> edition), Mosby / Elsevier, Philadelphia, pp-472</li> <li>3. Abbas, A. K and A. H. Lichtman. 2007. Cellular and Molecular Immunology (6<sup>th</sup> edition), W. B. Saunders, Philadelphia, pp-564</li> <li>4. Coica, R. Sunshine, G. 2015. Immunology (Seventh Edition), Wiley Blackwell, UK, pp-406.</li> </ol>	
<b>Recommended texts</b>	
<ol style="list-style-type: none"> <li>1. Weir, D. M and J. Stewart. 1997. Immunology, Churchill Livingstone, London, pp-362</li> <li>2. Janeway, C. A and P. Travers. 1997. Immunology, Garland Publ. Inc., London, pp-904</li> <li>3. Peakman, M and D. Vergani. 1997. Basic and Clinical Immunology, Churchill Livingstone, London, pp-366</li> <li>4. Parham, P. 2009. The Immune System (Third Edition), Garland Science, USA, pp-506</li> <li>5. Hood, L. Weissman, I. Wood, W. Wilson, J. 1984. Immunology (Second Edition), the Benjamin/Cummings, California, pp-558.</li> <li>6. Coica, R and Sunshine, G. 2009. Immunology A Short Course (Sixth Edition), John Wiley &amp; Sons, USA, pp-391.</li> <li>7. Doan, T. Melvold, R. Viselli, S. <i>et al.</i>, 2013. Immunology (Second Edition), Lippincott Williams &amp; Wilkins, Maryland, pp-376.</li> <li>8. Owen, J. A. Punt, J. Stanford, S. A. 2013. Kuby Immunology (7<sup>th</sup> Edition), Macmillan, England, pp-692.</li> </ol>	

<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>	S	M	S	S	S	S	M	S	S	S
<b>CO2</b>	S	S	M	S	S	S	M	M	S	S

<b>CO3</b>	S	M	M	S	S	S	S	S	S	M
<b>CO4</b>	M	S	M	M	S	S	S	S	S	M
<b>CO5</b>	M	S	S	S	M	S	M	S	S	M

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

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Knowing the ecology and climatic changes at world level and its impact on natural resources.	
<b>2.</b>	Understanding the contributing factors for pollution in the environment and the ways in controlling and restoring to natural conditions	
<b>Course I</b>	<b>:</b>	<b>Core IX</b>
<b>Course title</b>	<b>:</b>	<b>Ecology</b>
<b>Credits</b>	<b>:</b>	<b>4</b> <b>COURSE CODE: P23ZY409</b>
<b>Pre-requisite:</b>		
Students should know about the fundamentals and studied the ecology of living organisms.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
<b>1.</b>	Learn about the ecosystem, biotic communities and utilizing the energy processing	<b>K2</b>
<b>2.</b>	Study the various community and population and population control	<b>K2 &amp; K3</b>
<b>3.</b>	Understand the fundamentals of climatic conditions and its impact on environment	<b>K2 &amp; K6</b>
<b>4.</b>	Realizing the nature of pollution and the ways for its control/reduction	<b>K4 &amp; K5</b>
<b>5.</b>	Impact of environmental studies on solid waste management	<b>K2 &amp; K6</b>
<b>K1 - Remember; K2 - Understand; K3 - Apply; K4 - Analyze; K5 - Evaluate; K6 - Create</b>		
<b>Units</b>		
<b>I</b>	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.	
<b>II</b>	Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies ( <i>r</i> and <i>K</i> selection); concept of metapopulation-demes and dispersal, interdemec extinctions, age structured populations -action taken to control population explosion.	
<b>III</b>	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	

<b>IV</b>	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, eustarine). Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.
<b>V</b>	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).
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>1. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publication, India, pp-616.</li> <li>2. Calabrese, E.J. 1978. Pollutants and High-Risk Groups, John Wiley, pp-286.</li> <li>3. Raven, P.H. and L.R. Berg, G.B. Johnson, 1993. Environment, Saunders College Publishing, pp-579.</li> <li>4. Cunningham, W. P. and B. W. Saigo, 1999. Environmental Science, McGraw Hill Boston, 5th Edition.</li> <li>5. Online courses.nptel.ac.in / noc 19 - g e 23/preview</li> <li>6. Class central.com/course/swayam -ecology - and environment – 14021.</li> </ol>	
<b>Recommended texts</b>	
<ol style="list-style-type: none"> <li>1. Odum, E.P. 1893. Basic Ecology, Saunders &amp; Co., Philadelphia, pp-383.</li> <li>2. Barthwl, R.R. 2002. Environmental Impact Assessment, New Age International Publishers, New Delhi, India, pp-425.</li> <li>3. United Nations Environment Programme (UNEP). 1995. Global Biodiversity Assessment, Cambridge University Press, pp-1140.</li> </ol>	

<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>	S	S	M	M	S	M	S	S	M	S
<b>CO2</b>	S	S	M	M	L	S	S	S	M	M
<b>CO3</b>	S	M	M	L	M	S	L	L	S	L
<b>CO4</b>	M	M	S	S	M	L	L	S	S	S
<b>CO5</b>	M	S	S	M	S	M	L	M	L	S

\*S - Strong; M - Medium; L – Low

<b>Course</b>	<b>:</b>	<b>Core Project</b>
<b>Course title</b>	<b>:</b>	<b>Core Project with Viva voce</b>
<b>Credits</b>	<b>:</b>	<b>7</b> <b>COURSE CODE: P23ZY4PJ</b>



<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should know basic concepts of cattle and fowls rearing techniques	
<b>Course I</b>	<b>:</b>	<b>ELECTIVE VI – Industry/Entrepreneurship</b>
<b>Course title</b>	<b>:</b>	<b>Dairy and Poultry Farming</b>
<b>Credits</b>	<b>:</b>	<b>3 COURSE CODE: U23ZY4:A</b>
<b>Pre-requisite:</b>		
Students should be aware of economic and cultural importance of Poultry farming.		
<b>Expected Course Outcome:</b>		
Upon completion of this course, Students would have		
<b>I</b>	To understand the various practices in Poultry and Dairy farming. To know the needs for Poultry and Dairy farming and the status of India in global market.	<b>K2 &amp; K3</b>
<b>II</b>	To be able to apply the techniques and practices needed or Poultry and Dairy farming.	<b>K1, K2 &amp; K3</b>
<b>III</b>	To know the difficulties in Poultry and Dairy farming and be able to propose plans against it.	<b>K5 &amp; K6</b>

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

<b>Units</b>	
<b>I</b>	<b>General introduction and economic importance of poultry farming</b> - Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming, Management of chicks - growers and layers - Management of Broilers. - Farm and Water Hygiene - Recycling of poultry waste. Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.
<b>II</b>	Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme. Selection, care and handling of hatching eggs - Egg testing. Methods of hatching.- Brooding and rearing -. Sexing of chicks.
<b>III</b>	<b>Introduction and economic importance of Dairy Farming</b> .- Dairy cattle management-General Anatomy. Advantages of dairying- Classification of breeds of cattle-Indigenous and exotic breeds- Selection of dairy cattle. Breeding-artificial insemination- Construction of Model Dairy House - Types of Housing - Different Managemental Parameters - Winter Management - Summer Management
<b>IV</b>	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. Milk-Composition of milk-milk spoilage-pasteurization - Role of milk and milk products in human nutrition – Contagious disease -

	Common Bacterial - Protozoal - Helminth and Viral Diseases - Parasitic Infestation - Vaccination - Biosecurity.
V	Preparation of project report for banking and insurance. Value added products hands on training, Invited lectures from Universities, industries and experts. Field visit to various poultry and dairy farming. Dairying as a source of additional income and employment.
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>1. Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write &amp; Print Publications, New Delhi 2.</li> <li>2. Jull A. Morley, 2007. Successful Poultry Management. 2nd Edition. Biotech Books, New Delhi"</li> <li>3. Hurd M. Louis, 2003. Modern Poultry Farming. 1st Edition. International Book Distributing Company, Lucknow."</li> <li>4. Life and General Insurance Management"</li> <li>5. The Veterinary Books for Dairy Farmers by Roger W. Blowey.</li> <li>6. Hand Book of Dairy Farming by Board Eiri.</li> <li>7. Handbook of animal husbandry TATA, S.N ed., ICAR 1990</li> <li>8. Prabakaran, R. 1998. Commercial Chicken production. Published by P. Saranya, Chennai.</li> <li>9. Hafez, E. S. E., 1962. Reproduction in Farm Animals, Lea &amp; Fabiger Publisher.</li> </ol>	
<b>Recommended texts</b>	
<ol style="list-style-type: none"> <li>1. Ismail, S.A., 1997. Vermitechnology, The biology of earthworms, Orient Longman, India.</li> <li>2. <a href="http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf">http://www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf</a></li> <li>3. <a href="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</a></li> <li>4. <a href="http://ecoursesonline.iasri.res.in/course/view.php?id=335">http://ecoursesonline.iasri.res.in/course/view.php?id=335</a></li> <li>5. <a href="https://swayam.gov.in/nd2_nou19_ag09/preview">https://swayam.gov.in/nd2_nou19_ag09/preview</a></li> <li>6. <a href="https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Dairy%20unit.html">https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Dairy%20unit.html</a></li> <li>7. <a href="https://www.google.co.in/search?tbo=p&amp;tbm=bks&amp;q=inauthor:%22Tata,+S.N.,+ed%22">https://www.google.co.in/search?tbo=p&amp;tbm=bks&amp;q=inauthor:%22Tata,+S.N.,+ed%22</a></li> <li>8. 15. James. N. Marner, 1975. Principles of dairy processing, wiley eastern limited, New Delhi.</li> <li>9. Baradach, JE. Ryther. JH. and, MC larney WO., 1972. Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley InterScience, New York.</li> </ol>	

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

\*S - Strong; M - Medium; L – Low

<b>Course Objectives:</b>		
The main objectives of this course are:		
<b>1.</b>	Students should gain basic knowledge intellectual property.	
<b>Course I</b>	:	<b>SEC- III Professional Competency Course I</b>
<b>Course title</b>	:	<b>Intellectual Property Rights</b>
<b>Credits</b>	:	<b>2</b>
<b>Pre-requisite:</b>		
Students should be aware of importance of analysis of quantitative and qualitative information from biological studies.		
<b>Expected Course Outcome:</b>		
On the successful completion of the course, student will be able to		
I	Claim the rights for the protection of their invention done in their project work.	<b>K1 &amp; K3</b>
II	Identify criterias' to fit one's own intellectual work in particular form of IPRs	<b>K4 &amp; K5</b>
III	To get registration in our country and foreign countries of their invention, designs and thesis or theory written by students during their project.	<b>K1, K2 &amp; K3</b>

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

<b>Units</b>	
<b>I</b>	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.
<b>II</b>	Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad
<b>III</b>	International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.
<b>IV</b>	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.
<b>V</b>	Infringement of IPRs, Enforcement Measures, Emerging issues - Case Studies.
<b>Reading list</b>	
<ol style="list-style-type: none"> <li>Deborah E. Bouchoux, "Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets", Cengage Learning, Third Edition, 2012.</li> <li>Prabuddha Ganguli,"Intellectual Property Rights: Unleashing the Knowledge Economy", McGraw Hill Education, 2011.</li> </ol>	

3. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.

**Recommended texts**

1. V. Scope 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.

<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>	S	S	M	M	M	S	S	M	M	M
<b>CO2</b>	S	S	M	S	M	S	S	S	M	L
<b>CO3</b>	S	M	M	S	M	L	L	S	L	S
<b>CO4</b>	M	M	S	L	M	S	S	S	S	S
<b>CO5</b>	M	S	S	L	S	M	M	L	L	S

\*S - Strong; M - Medium; L – Low

