

# UG Zoology (2023 Board)

## SEMESTER I CORE COURSE I: INVERTEBRATA

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU231CC1	4	1	-	1	4	6	90	25	75	100

### Pre-requisite

Students need to know the classification of invertebrates based on their morphology and Anatomy.

### Learning Objectives:

1. To distinguish the characteristic features and function, evolutionary position, economic importance, and interaction with the environment of invertebrates.
2. To develop the skill of identification of invertebrates and to promote employability in museum, consultancy firms and educational institutions.

### Course Outcome

COs	On completion of this course, students will;	CL
CO 1	understand the basic concepts of invertebrate animals and recall its structure and functions.	K1
CO 2	illustrate and examine the systemic and functional morphology of various groups of invertebrates.	K2
CO 3	differentiate and classify the animal's mode of life in various taxa and estimate the biodiversity.	K3

**K1** - Remember; **K2** - Understand; **K3** – Apply

UNIT	Contents	No. of Hours
I	<p><b>Protozoa:</b> Introduction to Classification, taxonomy, and nomenclature. General characters and classification of Phylum Protozoa up to classes. Type study: <i>Paramecium</i> (Morphology and Reproduction) and <i>Plasmodium</i> (Lifecycle)- Parasitic protozoans (<i>Entamoeba</i>, <i>Trypanosoma</i> &amp; <i>Leishmania</i>) - Economic importance Nutrition in protozoa - Host-parasitic interactions in <i>Entamoeba</i> and <i>Plasmodium</i>- Locomotion in protozoa</p> <p><b>Porifera:</b> General characters and classification up to Classes. Type study: Sycon- Canal system in sponges. Reproduction in sponges. Skeleton in sponges.</p>	18
II	<p><b>Coelenterata :</b> General characters and classification up to classes – Type study: <i>Obelia</i> (Morphology and lifecycle)- Corals and coral reefs - Economic importance of corals and coral reefs - Polymorphism in Hydrozoa.</p>	18

	<b>Platyhelminthes:</b> General characters and classification of up to classes. Type study: <i>Fasciola hepatica</i> (Morphology and lifecycle)-. Parasitic adaptations. Host-parasitic interactions of Helminthine parasites	
III	<b>Aschelminthes :</b> General characters and classification of up to classes - Type study: <i>Ascaris lumbricoides</i> (Morphology and lifecycle), Nematode Parasites and diseases - <i>Wuchereriabancrofti</i> , <i>Enterobius vermicularis</i> , <i>Ancylostoma duodenale</i> . Parasitic adaptations. <b>Annelida:</b> General characters and classification up to Classes. Type study: <i>Nereis</i> (Morphology) ,Metamerism- Modes of life in Annelids. Reproduction in polychaetes.	18
IV	<b>Arthropoda:</b> General characters and classification of Phylum Arthropoda up to Classes. Type study: <i>Panaeus indicus</i> (Morphology and reproduction). Affinities of <i>Peripatus</i> – Larval forms in Crustacea. Economic importance of Insects. Insect pests of Agricultural Importance- Pest of rice: Rice stem borer ( <i>Scirpophagaincertulas</i> ) – Pest of Sugarcane: The shoot borer ( <i>Chilo infuscatellus</i> ) – Pest of coconut: The rhinoceros beetle ( <i>Oryctes rhinoceros</i> ). Principles of Integrated Pest Management.	18
V	<b>Mollusca:</b> General characters and classification of Phylum Mollusca up to Classes. Type study: <i>Pila globosa</i> . Foot and torsion in Mollusca. Economic importance- Cephalopods. <b>Echinodermata:</b> General characters and classification of Phylum Echinodermata up to Classes. Type study: <i>Asterias</i> . Water Vascular system in Echinodermata – Larval forms of Echinoderms.	18

<b>Self-study</b>	Nutrition in Protozoa; Corals and coral reefs; <i>Nereis</i> ; <i>Panaeus indicus</i> – Morphology; Economic importance- Cephalopods
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### Text Books

1. Ekambaranatha Ayyar, and T. N. Ananthakrishnan, 2000. A Manual of Zoology. Vol 1 (Invertebrata). Part II – Viswanathan Pvt. Ltd.
2. Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12<sup>th</sup> edn. S. Chand & Co.
3. Kotpal R.L. 2019. Modern Text Book of Zoology, Invertebrates 9<sup>th</sup> Ed., Rastogi Publications, Gangotri, Shivaji Road, Meerut.
4. Vasantharaj David, B. 2001. Elements of Economic Entomology, Popular Book Depot, Chennai.
5. Ruppert and Barnes, R.D. 2006. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition, Belmont, CA : Thomson-Brooks/Cole.

### References Books

1. Barrington, E.J.W., 2012, Invertebrate structure and function. Boston – Houghton. Mifflin and ELBS, London.
2. Bhamrah, H.S. and Kavitha Juneja, 2002. A text book of Invertebrates. Alilnol Publications

Private Limited, 4374/4B.Ansari Road, Dayaganj, New Delhi.

3. Hyman L.H, 1955. The invertebrates – Vol. I to Vol. VII – McGraw Hill Book Co.
4. Kotpal, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, R.L- Rastogi Publication.
5. Parker, J. and Haswell , 1978. A text book of Zoology Vol. I - Williams and Williams.
6. Srivastava, M.D.L and Srivastava, 1969. A text book of Invertebrate Zoology, U.S-Central Book Depot, Allahabad.
7. Verma, A. Invertebrates: Protozoa to Echinodermata. Narosa Publishing House Private Limited.35-36 Greams Road, Thousand Lights, Chennai.

### Web Resources

1. <https://www.nationalgeographic.com/animals/invertebrates/>
2. <https://bit.ly/3kABzKa>
3. <https://www.nio.org/>
4. <https://bit.ly/3IJdUX0>
5. <https://greatbarrierreef.org/>

### MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO 1</b>	3	3	1	3	3	1	3
<b>CO 2</b>	3	2	2	2	2	1	3
<b>CO 3</b>	3	3	1	2	3	2	3
<b>TOTAL</b>	9	8	4	7	8	4	9
<b>AVERAGE</b>	3	2.6	1.3	2.3	2.6	1.3	3

**3 – Strong, 2 – Medium, 1 - Low**

### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

Cos	PSO1	PSO2	PSO3	PSO4	PSO5
<b>CO1</b>	3	3	2	3	2
<b>CO2</b>	3	3	2	2	3
<b>CO3</b>	2	2	3	2	2
<b>Total</b>	8	8	7	7	7
<b>Average</b>	2.6	2.6	2.3	2.3	2.3

**SEMESTER I**  
**CORE LAB COURSE I: INVERTEBRATA**

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZU231CP1	-	-	2	-	-	2	30	25	75	100

**Pre- requisite:**

Students should be aware of invertebrate animals and their living environments

**Learning objectives:**

1. To enable students to identify different groups of invertebrate animals by observing their external characteristics and understand their adaptations to various environments and modes of life.
2. To develop students' practical skills in invertebrate anatomy through dissection, internal organ display, and mounting of mouthparts and scales, enhancing their understanding of invertebrate structures and functions.

**Course outcome**

On completion of this course, students will be able to:		
<b>CO1</b>	identify and label the external features of different groups of invertebrate animals.	<b>K1</b>
<b>CO2</b>	illustrate and examine the circulatory system, nervous system, and reproductive system of invertebrate animals.	<b>K2</b>
<b>CO3</b>	differentiate and compare the structure, function, and mode of life of various groups of animals.	<b>K3</b>
<b>CO4</b>	to compare and distinguish the dissected internal organs of lower animals.	<b>K4</b>
<b>CO5</b>	prepare and develop the mounting procedure of economically important invertebrates.	<b>K5</b>

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

UNIT	Details	No. of Hours
I	<b>Major Dissection:</b> Cockroach: Nervous system, Reproductive system.	6
II	<b>Minor Dissection:</b> Cockroach: Digestive system.	6
III	<b>Mounting:</b> Cockroach: Mouth parts - Honey Bee/ House fly/ Mosquito. Prawn: Appendages	6
IV	Record / Observation Note ( <b>Submission Is Mandatory</b> )	6
V	<b>Spotters:</b> (i). Protozoa: Amoeba, Paramecium, Paramecium Binary fission and Conjugation, Entamoeba histolytica, Plasmodium vivax (ii). Porifera: Sycon, Gemmule (iii). Coelenterata: Obelia – Colony & Medusa, Aurelia, Physalia, Gorgonia, (iv). Platyhelminthes: Planaria, Fasciola hepatica, Fasciola larval forms – Miracidium, Redia, Cercaria, Taenia solium, (v). Nematelminthes: Ascaris (Male & Female), vi). Annelida: Nereis, Chaetopteurs, Hirudinaria, Trochophore larva (vii). Arthropoda: Cancer, Palaemon, Scorpion, Scolopendra, Sacculina, Limulus, Peripatus, Larvae - Nauplius, Mysis, Zoea, (viii). Mollusca: Chiton, Pila, Unio, Pteredo, Murex, Sepia, Loligo, Octopus, (ix). Echinodermata: Asterias, Ophiothrix,	6

	Cucumaria, Antedon, Bipinnaria larva.	
	<b>Total</b>	<b>30</b>

### Text Books

1. Ekambaranatha Ayyar, and T. N. Ananthakrishnan, 2000. A Manual of Zoology. Vol 1 (Invertebrata). Part II – Viswanathan Pvt. Ltd.
2. Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12<sup>th</sup> edn. S. Chand & Co.
3. Kotpal R.L. 2019. Modern Text Book of Zoology, Invertebrates 9<sup>th</sup> Ed., Rastogi Publications, Gangotri, Shivaji Road, Meerut.
4. Vasantharaj David, B. 2001. Elements of Economic Entomology, Popular Book Depot, Chennai. .
5. Ruppert and Barnes, R.D. 2006. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition, Belmont, CA: Thomson-Brooks/Cole.

### References Books

1. Barrington, E.J.W., 2012, Invertebrate structure and function. Boston – Houghton. Mifflin and ELBS, London.
2. Hyman L.H, 1955. The invertebrates – Vol. I to Vol. VII – McGraw Hill Book Co.
3. Kotpal, 1992. Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata, R.L- Rastogi Publication.
4. Parker, J. and Haswell, 1978. A text book of Zoology Vol. I - Williams and Williams.
5. Srivastava, M.D.L and Srivastava, 1969. A text book of Invertebrate Zoology, U.S- Central Book Depot, Allahabad.

### Web Resources

1. <https://www.nationalgeographic.com/animals/invertebrates/>
2. <https://bit.ly/3kABzKa>
3. <https://www.nio.org/>
4. <https://bit.ly/3IJdUX0>

### MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO 1</b>	3	3	1	2	3	1	2
<b>CO 2</b>	3	2	2	3	2	1	3
<b>CO 3</b>	3	3	1	2	3	2	3
<b>CO 4</b>	3	3	1	2	3	1	2
<b>CO5</b>	2	1	3	2	3	3	3
<b>TOTAL</b>	14	12	13	11	14	8	13
<b>AVERAGE</b>	2.8	2.4	2.6	2.2	2.8	1.6	2.6

**3 – Strong, 2 – Medium, 1 - Low**

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

<b>COs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	3	3	3	3	2
<b>CO2</b>	3	2	2	2	3
<b>CO3</b>	2	3	3	2	2
<b>CO4</b>	3	3	3	3	3
<b>CO 5</b>	2	3	2	3	2
<b>Total</b>	13	14	13	13	12
<b>Average</b>	2.6	2.8	2.6	2.6	2.4

**SEMESTER I**  
**ELECTIVE COURSE I- ALLIED ZOOLOGY I**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU231EC1	3	1	-	-	3	4	60	25	75	100

**Pre-requisite:**

Students should be common aware of living organisms and their basic morphological differentiations from biological studies.

**Learning Objectives**

1. To acquire a basic knowledge of diversity and organization of Protozoa, Coelenterata, Helminthes, Annelida, Arthropoda, Mollusca and Echinodermata.
2. To comprehend the taxonomic position and diversity among Protochordata, Pisces, Amphibia, Reptilia, Aves and Mammalia.

**Course Outcomes**

On the successful completion of the course, student will be able to:		
CO1	relate the characteristic features in invertebrates and chordates.	K1 & K2
CO2	classify invertebrates up to class level and chordates up to order level.	K2 & K4
CO3	identify the structural and functional organization of few invertebrates and chordates.	K3 & K4
CO4	survey the adaptations and habits of animals to their habitat.	K4 & K5
CO5	assess the taxonomic position of invertebrate and chordate animals.	K5 & K6

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

Unit	Contents	Hours
Unit I	Diversity of Invertebrates–I: Principles of taxonomy. Criteria for classification– Symmetry and Coelom–Binomial nomenclature. Classification of Protozoa, Coelenterata, Helminthes and Annelida up to classes with two examples.	12
Unit II	Diversity of Invertebrates–II: Classification of Arthropoda, Mollusca and Echinodermata up to class level with examples.	12
Unit III	Diversity of Chordates–I: Classification of Prochordata, Pisces and Amphibia up to orders giving two examples.	12
Unit IV	Diversity of Chordates–II: Classification of Reptilia, Aves and Mammalia up to orders giving two examples.	12
Unit V	Animal organization Structure and organization of (i) Earthworm (ii) Prawn/Fish (iii) Rabbit/Rat	12

**Textbook**

1. Ekamberanatha Ayyar M. (1990). A Manual of Zoology, Volume I. Invertebrate Part I and Part II S. Viswanathan Printers & Publishers Pvt. Ltd.
2. Hickman, C, Keen, S, Larson, A, Eisenhour, D and Roberts, L. 2021. Animal Diversity (9<sup>th</sup> Edition).

## Reference Books

1. Ekambaranatha Iyer M. and Anantakrishnan T. N. (1990): *A manual of Zoology*. Vol. I. Invertebrata (Part 1 &2). S. Vishwanathan Pvt. Ltd.
2. Ekambaranatha Iyer M. and Anantakrishnan T. N. (1990): *A manual of Zoology*. Vol. II. Chordata S. Vishwanathan Pvt. Ltd.
3. Jordan E. L. and Verma P.S. (1976): *Chordate Zoology*. S. Chand & Co. Jordan E. L. and Verma P.S. (1976): *Invertebrate Zoology*. S. Chand & Co.
4. Kotpal R. L. (1993): *Protozoa- Echinodermata* (all volumes). Rastogi Publ. Pough H (2004): *Vertebrate life*, VIII Edition, Pearson International.
5. Ruppert and Barnes, R.D. (2006): *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition

## Web Resources

1. <https://blogs.ubc.ca/mrpletsch/2019/09/10/unit-1-1-principals-of-taxonomy/>
2. <https://byjus.com/biology/animal-kingdom-basis-classification/>
3. <https://www.britannica.com/animal/arthropod/Classification>
4. <https://www.geeksforgeeks.org/phylum-chordata/>
5. [https://www.brainkart.com/article/Phylum-Chordata-and-Diversity-and-General-Characters-of-Chordates\\_587/](https://www.brainkart.com/article/Phylum-Chordata-and-Diversity-and-General-Characters-of-Chordates_587/)
6. [https://youtu.be/19dPFqd-H\\_o](https://youtu.be/19dPFqd-H_o)
7. <https://youtu.be/QRYVvRRmJRU>
8. <https://www.biologydiscussion.com/invertebrate-zoology/phylum-arthropoda/study-notes-on-prawn/33417>

### MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO 1	3	2	3	3	2	3	2
CO 2	3	2	3	3	2	3	2
CO 3	3	2	3	3	2	3	2
CO 4	3	2	3	3	3	3	2
CO 5	3	2	3	3	3	3	2
Total	15	10	15	15	12	15	10
Average	3	2	3	3	2.4	3	2

S- Strong (3) M-Medium (2) L-Low (1)



## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

<b>COs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	3	3	3	3	2
<b>CO2</b>	3	2	2	2	3
<b>CO3</b>	2	2	3	2	2
<b>CO4</b>	3	3	3	3	3
<b>CO 5</b>	2	2	2	3	3
<b>Total</b>	13	12	13	13	13
<b>Average</b>	2.6	2.8	2.6	2.6	2.6

**SEMESTER I**  
**ELECTIVE LAB COURSE - LAB ON ALLIED ZOOLOGY I**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU231EP1	-	-	2	-	2	2	30	25	75	100

**Pre-requisite:**

Students should be aware of surrounding living invertebrates and vertebrates and their basic structural differentiations and their habitats.

**Learning Objectives**

1. To understand the structure and label the various parts of the dissected organisms.
2. Enable the students to understand, identify and classify the various fauna surrounding them.

**Course Outcomes**

On the successful completion of the course, student will be able to:		
CO1	compare and distinguish the dissected internal organs of animals.	K1
CO2	prepare and develop the mounting procedure of important invertebrate and chordate anatomical parts.	K2
CO3	identify and label the external features of different groups of invertebrates.	K3
CO4	analyze the ecological roles and significance of the organisms within their ecosystems.	K4
CO5	evaluate evolutionary relationships and broader biological concepts among the spotted organisms.	K5

**K1** - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyse; **K5** - Evaluate

S.No	Details
1.	<b>DISSECTION:</b> 1. Cockroach - digestive system 2. Cockroach - nervous system 3. Fish-digestive system
2.	<b>MOUNTING:</b> 1. Mouth parts- Cockroach 2. Mouth parts - Mosquito 3. Scales -Placoid, Cycloid and Ctenoid 4. Prawn appendages
3.	<b>SPOTTERS-</b> <i>Paramecium, Plasmodium, Scypha, Leucosolenia, Corals. Taenia solium</i> – entire, <i>Ascaris</i> male and female. Earthworm, Prawn, Scorpion, Pila, Starfish Amphioxus, Shark, Frog, Calotes, Pigeon feather

**Text Books**

1. EkambaranathaIyyar and T. N. Ananthakrishnan, 1995 A manual of Zoology Vol.I (Part 1, S. Viswanathan, Chennai.

2. Ganguly, Sinha and Adhikari, 2011. Biology of Animals: Volume I, New Central Book Agency; 3rd revised edition.
3. Sinha, Chatterjee and Chattopadhyay, 2014. Advanced Practical Zoology, Books & Allied Ltd; 3rd Revised edition.
4. Lal, S. S., 2016. Practical Zoology Invertebrate, Rastogi Publications.
5. Verma, P. S. 2010. A Manual of Practical Zoology: Invertebrates, S Chand.
6. Lal S S, 2009. Practical Zoology Vertebrate, Rajpal and Sons Publishing, 484pp.

#### References Books

1. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
2. Barnes, R.D. (1982). Invertebrate Zoology, V Edition. Holt Saunders International Edition.
3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
4. Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home.
5. Lal, S.S. 2005. A text Book of Practical Zoology: Invertebrate, Rastogi, Meerut

#### Web Resources

1. <https://nbb.gov.in/>
2. <http://www.agshoney.com/training.htm>
3. <https://icar.org.in/>
4. <http://www.csrtimys.res.in/>
5. <http://csb.gov.in/>
6. <https://iinrg.icar.gov.in/>
7. <https://www.nationalgeographic.com/animals/invertebrate>

#### MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO 1</b>	3	3	1	2	3	1	2
<b>CO 2</b>	3	2	2	3	2	1	3
<b>CO 3</b>	3	3	1	2	3	2	3
<b>CO 4</b>	3	3	1	2	3	1	2
<b>CO 5</b>	2	2	2	3	1	2	2
<b>TOTAL</b>	14	13	12	12	12	7	12
<b>AVERAGE</b>	2.8	2.6	2.4	2.4	2.4	1.4	2.4

**3 – Strong, 2 – Medium, 1 - Low**

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

<b>COs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	3	3	3	3	2
<b>CO2</b>	3	2	2	2	3
<b>CO3</b>	2	3	3	2	2
<b>CO4</b>	3	3	3	3	3
<b>CO 5</b>	2	3	2	3	2
<b>Total</b>	13	14	13	13	12
<b>Average</b>	2.6	2.8	2.6	2.6	2.4

**SEMESTER I**  
**NON-MAJOR ELECTIVE NME I**

**ORNAMENTAL FISH FARMING & MANAGEMENT**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU231NM1	1	-	-	1	2	2	30	25	75	100

**Pre- requisite**

Introductory understanding of basic aquaculture principles and fish biology.

**Learning Objectives**

1. To identify various ornamental fish species, their habitat requirements, and the key factors influencing their health and well-being in captivity.
2. To gain skills on the techniques of ornamental fish breeding, rearing, disease control and economics of ornamental fish farming.

**Course Outcome:**

On the successful completion of the course, student will be able to:		
CO1	identify commercially important ornamental fishes, including indigenous and exotic varieties.	K1
CO2	explore food and feeding habits in ornamental fishes, including formulated feed and live feed.	K2
CO3	gain expertise in the maintenance of aquariums and water quality management.	K3

**K1 - Remember; K2 - Understand; K3 - Apply**

Units	Contents	No. of Hours
I	Introduction to ornamental fish keeping. Scope and importance of ornamental fish culture. Domestic and global scenario of ornamental fish trade and export potential. Commercially important ornamental fishes - Indigenous and exotic varieties.	6
II	Biology of egg layers and live bearers. Food and feeding in ornamental fishes. Formulated feed and Live feed; Live feed culture. Breeding, hatchery and nursery management of egg layers (e.g. Goldfish) and live bearers (e.g. Guppy).	6
III	Aquarium design and construction; Accessories - aerators, filters and lighting. Aquarium plants and their propagation. Maintenance of aquarium and water quality management. Ornamental fish diseases, their prevention, control and treatment methods.	6
IV	Conditioning, packing, transport, and quarantine methods. Economics, trade regulations, domestic and export marketing strategies.	6
V	<b>Practical</b> 1) Identification of locally available ornamental fishes - Egg layers and live bearers.	6

2) Identification of locally available live feed organisms.
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<b>Self-Study</b>	Scope and importance of ornamental fish culture, Food and feeding in ornamental fishes, Aquarium construction; Accessories - aerators, filters and lighting, Export marketing strategies

**Text books**

1. Swain SK., Sarangi N. and Ayyappan S. 2010. Ornamental fish farming. ICAR, New Delhi.
2. Living Jewels – A handbook on freshwater ornamental fish, MPEDA, Kochi.
3. Dey V.K.A. 1997. A handbook on aquafarming ornamental fishes. MPEDA, Kochi.
4. Ahilan, B., Felix N. and Santhanam R. 2008. Text book of aquaculture. Daya Publishing House, New Delhi.

**References:**

1. Tarit Kumar Banrjee (2016). *Applied Zoology*. London: New Central Agency (P) Ltd.
2. Supriti Sarkar, Gautam Kundu, Korak Kanti Chaki (2016). *Introduction to Economic Zoology* London: New Central Agency (P) Ltd.
3. Nagendra S. Pawar. (2008). *Applied Zoology*. New Delhi: Adhyayan Publishers.
4. Sukumar De. (2005). *Outlines of Dairy Technology*. New Delhi: Oxford University Press.
5. Williamson. G and Payne. J. A. (1978). *An introduction to Animal Husbandry in the Tropics*. London: Longman Group Limited.

**Web links:**

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=297>
2. <https://www.ofish.org/>
3. <https://krishijagran.com/agripedia/income-generation-by-ornamental-fish-culture/>
4. <https://99businessideas.com/ornamental-fish-farming/>

**MAPPING WITH PROGRAMME OUTCOMES**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	3	1	3
CO2	3	3	3	3	3	3	1
CO 3	1	1	2	2	2	3	3
<b>TOTAL</b>	7	6	7	6	8	7	7
<b>AVERAGE</b>	2.3	2	2.3	2	2.6	2.3	2.3

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

**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	2
CO2	3	2	2	2	3
CO3	2	3	3	2	2
<b>Total</b>	8	8	8	8	8
<b>Average</b>	2.6	2.6	2.6	2.6	2.6

## SEMESTER I

### FOUNDATION COURSE - INTRODUCTION TO ZOOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZU231FC1	1	1	-	-	2	2	30	25	75	100

#### Pre-requisite:

Students should know the basic concepts of biology such as systemic classification, Grades in organization, parts of the cell, role of environment, culture of different organisms.

#### Learning objectives

1. To provide the knowledge of fundamental principles in zoology that will be a foundation for their later advanced courses in more specific biological subjects.
2. Familiarize with animal classification schemes and diagnostic characteristics as well as developing an understanding of and ability to apply basic zoological principles.

#### Course Outcomes

COS	On the successful completion of the course, student will be able to:	Cognitive level
CO1	describe the basic concepts of taxonomy, organization, structure and role of cell, environmental issues, importance of culturing organisms.	<b>K1</b>
CO2	apply classification principles and identify animals, its organ system on the basis of its function, environmental problems, benefits of culturing organisms.	<b>K2</b>
CO3	enhance leadership qualities, team spirit, participate in learning activities and communicate effectively among the peer.	<b>K3</b>

**K1** - Remember; **K2** - Understand; **K3** - Apply

Unit	Content	Hours
<b>I</b>	<b>Systematic and binomial system of nomenclature:</b> meaning of the terms taxonomy, Systematic, classification and nomenclature, Need of classification. <b>Systematics:</b> Kingdom Protista- Salient features, examples; Kingdom Animalia- <b>Introduction to different Phyla:</b> Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminths, Annelida, Arthropoda, Mollusca, Echinodermata, Hemichordata and Chordata	6
<b>II</b>	<b>Physiology and Biochemistry:</b> Introduction to organ systems- Digestive, Respiratory system, Endocrine and Circulatory system, Urinogenital system, Nervous system, Reproductive system.	6
<b>III</b>	<b>General structure Cell:</b> Ultrastructure of prokaryotic and eukaryotic cell. Different cell organelles- endoplasmic reticulum, Golgi bodies, mitochondria,	6

	lysosome, nucleus, nucleolus. Modern concept of gene: DNA as genetic material, structure of DNA as given by Watson and Cricks model and RNA.	
IV	<b>Environmental Biology:</b> Principal layers of atmosphere- Exosphere, Thermosphere, Mesosphere, Stratosphere, Troposphere. Lithosphere Hydrosphere, Environmental issues- Global warming, green house effects, acid rain.	6
V	<b>Applied Zoology:</b> Aquaculture - Pisciculture, Prawn culture and Pearl culture, Sericulture, Apiculture.	6

<b>Self-Study</b>	Need of classification, Organisation - organ systems, Differentiation of Prokaryotic and Eukaryotic cell, Outline of layers of atmosphere.
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### Text books

1. Ekambaranatha Iyer, 2000. A Manual of Zoology, 10<sup>th</sup> edition, Viswanathan, S., Printers & Publishers Pvt Ltd.
2. Kumar P. and Mina U. (2018) Life Sciences: Fundamentals and Practice, Part-I, 6th Edn., Pathfinder Publication.
3. Verma P.S. and Agarwal V.K. (2016). Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand, and Company Ltd.
4. Verma P.S., Tyagi B.S & Agarwal V.K., 2010. Animal Physiology, S. Chand & Co. Ltd., New Delhi Publishing.
5. Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R., Applied Zoology, 2020, Saras Publication, Nagercoil.

### References

1. Jordan, E.L. and Verma P.S, 1995. Invertebrate Zoology, 12<sup>th</sup> edn. S. Chand & Co
2. Kotpal R.L. 2019. Modern Text Book of Zoology, Invertebrates 9<sup>th</sup> Ed., Rastogi Publications, Gangotri, Shivaji Road, Meerut.
3. Rastogi, S.C., Cell Biology, 2008, New Age International (P) Limited, Publishers, New Delhi, 2<sup>nd</sup> Ed.
4. Powar, C.B., Cell Biology, 2013. Himalaya publishing House, Bombay.
5. Goel, K. A. and K.V. Sastry. 1998, A Text Book of Animal Physiology, 6<sup>th</sup> Revised edition. Rastogi Publications
6. Sarada Subrahmanyam, Madhavan Kutty, K., & Singh H.D., 2018. Text Book of Human Physiology, S. Chand & Co, New Delhi.
7. Sreekumar, S. 2010. Basic physiology, PHI learning private ltd., New Delhi.
8. Saha, T.K. 2010. Ecology and Environmental biology, Books and Allied, Kolkata.
9. Concepts of Aquaculture. Santhana Kumar and A. M. Selvaraj. 2012. Meenam Publications, Nagercoil.

### 10. Web Resources

1. <https://byjus.com/biology/animal-kingdom-animalia-subphylum/>
2. <https://www.verywellhealth.com/organ-system-1298691>
3. <https://biologydictionary.net/organ-system/>
4. <https://www.noaa.gov/jetstream/atmosphere/layers-of-atmosphere>



**SEMESTER - I**  
**SPECIFIC VALUE-ADDED COURSE**  
**PET KEEPING AND CARE**

Course Code:	Credits	Total Hours	Total Marks
ZU231V01	1	30	100

**Pre requisite:**

A foundational knowledge of animal behaviour, basic care practices, and an interest in the welfare of animals is important.

**Objectives:**

To provide comprehensive knowledge about pet ownership and promote awareness of ethical responsibilities towards pets.

<b>On completion of this course, students will be able to:</b>		
CO 1	identify legal regulations and guidelines related to pet ownership	K1
CO 2	interpret pet behaviour and communication cues	K2
CO 3	utilize grooming routines and implement basic first aid and emergency care techniques.	K3
CO 4	analyze the impact of legal regulations on animal welfare and responsible pet care.	K3
CO 5	assess living conditions and space availability and the appropriateness of nutrition and feeding plans.	K5
CO 6	design strategies for responsible pet selection based on living conditions and lifestyle	K6

Unit	Content	Hours
I	<b>Introduction to Pet Keeping:</b> Importance of pets in Indian culture and society - commonly kept pets in India and their roles - Legal regulations and guidelines for pet ownership - Cultural considerations in pet care - Ethical responsibilities towards pets and animal welfare.	6
II	<b>Selecting the Right Pet:</b> Assessing living conditions and space availability - Choosing pets based on lifestyle and family dynamics - Pros and cons of popular pet choices - Identifying local and indigenous pet breeds.	6
III	<b>Practical Aspects of Pet Care:</b> Nutrition and feeding practices - Grooming routines - common health concerns specific to India - Basic first aid and emergency care.	6
IV	<b>Nurturing Healthy Relationships with pets:</b> Pet behaviour and communication - Training techniques for pets and households - promoting mental and physical stimulation for pets.	6
V	<b>Community Engagement and Advocacy:</b> Promoting responsible pet ownership in local communities - organizing and participating in pet care workshops - Collaborating with local animal welfare organizations - raising awareness about pet-related issues in India.	6

**Reference books:**

1. David Alderton: The complete book of pets & pet care: the essential family reference guide to pet breeds and pet care
2. Selvam R.K. Veera. 2010. Handbook of per care and management. Soujanya Books. 1<sup>st</sup>edn. Jaipur.
3. Dash, S.K. 2008. Hand book of veterinary practices. 1<sup>st</sup> edition. Kalyani Publishers.
4. Sapre, V A. and Dakshinkar, N.P. 2020. Hand book for veterinary physician. 17<sup>th</sup>edn. CBS Publishers.
5. Bhikane, A.U. and Kawithar, S.B. 2022. Handbook for veterinary clinicians. AgriBiovet

**SEMESTER II**  
**CORE COURSE II: CHORDATA**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU232CC1	4	1	1	-	6	6	90	25	75	100

**Pre-requisite**

Students should know the taxonomical classification of chordates in relation to their functional morphology.

**Learning objectives**

1. To develop an in-depth knowledge on the structures and distinct features of Phylum Chordata.
2. To identify the animals of each subphylum and class based on their characteristic features.

**Course Outcomes**

<b>On the successful completion of the course, student will be able to:</b>		
1	recall the name and distinct features of different sub phylum belonging to phylum Chordata.	<b>K1</b>
2	explain the structural organization, function and evolutionary aspects of chordates.	<b>K2</b>
3	interpret the biological significance and the conservation of chordates.	<b>K3</b>

**K1** - Remember; **K2** - Understand; **K3** - Apply

Units	Contents	No. of Hours
I	General Characters and Classification of Phylum Chordata: origin of Chordata, differences between non-chordates and chordates, general characters, affinities and systematic position of Hemichordata ( <i>Balanoglossus</i> ), Urochordata( <i>Ascidia</i> ), Cephalochordata ( <i>Amphioxus</i> ).	18
II	Agnatha: Characteristics of subphylum vertebrata. General characters and classification up to class level, Agnatha ( <i>Petromyzon</i> ), - Pisces ( <i>Scoliodonsorrakowah</i> ), circulatory system, sense organs. - types of scales and fins - accessory respiratory organs - air bladder - parental care - migration - economic importance.	18
III	Amphibia: General characters and classification up to orders with names of the examples only - Type study – <i>Ranahexadactyla</i> - Morphology, Digestive system,	18

	respiratory system, Urinogenital system, Endoskeleton: Skull, typical vertebra, atlas, girdles and limbs. Adaptive features of Anura, Urodela and Apoda - Neoteny in Urodela - Parental care in Amphibia.	
IV	Reptilia: General characters and classification - Type study – ( <i>Calotes versicolor</i> - Morphology, endoskeleton of <i>Varanus</i> ). Extinct reptiles. Snakes of South India: Poisonous snakes - <i>Naja naja</i> , King cobra and Viper, Non-poisonous snakes - Python, Rat snake ( <i>Ptyas mucosa</i> ) and Wolf snake ( <i>Lycodon aulicus</i> ). Poison apparatus and biting mechanism of poisonous snakes - Skull in reptiles as basis of classification	18
V	Aves and Mammalia: Aves: general characters and classification – type study - <i>Columba livia</i> - exoskeleton - flight adaptations, Migration. Mammalia: general characters and classification - type study - Rabbit - nervous system. Adaptations of aquatic mammals, egg laying mammals, marsupials, flying mammals. Dentition in mammals.	18
<b>Self-study</b>	General characters of Chordates, types of scales and fins. Parental care in amphibia, Poisonous snakes and Flight adaptations	

### Text book

1. N. Arumugam, A. Thangamani, S. Prasanna Kumar, L.M. Narayanan, 2022. Chordate Zoology, Saras Publication, Nagercoil.
2. Kotpal, R. L. 2019. Chordata and Comparative Anatomy. Rastogi publications. Meerut, U.P.

### References Books

1. Singh, B.D. A Text Book of Zoology Chordata Paperback – 1. Kedar Nath Ram, Meerut, Uttar Pradesh.
2. Kotpal, R.L. A, 2009. Modern text book of Zoology Vertebrates, Rastogi publications. Meerut, U.P.
3. Young, J. Z., 2004. The Life of Vertebrates. III Edition. Oxford university press.
4. Waterman, Allyn J. et al., 1971. Chordate Structure and Function, Mac Millan & Co., New York.
5. Hall B.K. and Hallgrímsson B., 2008. Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

### Web resources

1. <https://byjus.com/biology/phylum-chordata-classification/>
2. <https://www.uou.ac.in/sites/default/files/slm/BSCZO-201.pdf>
3. <https://sunyorange.edu/biology/resources/library/prehistoric-life/chordates.html>
4. [https://sist.sathyabama.ac.in/sist\\_coursematerial/uploads/SBC1201.pdf](https://sist.sathyabama.ac.in/sist_coursematerial/uploads/SBC1201.pdf)
5. <file:///C:/Users/91944/Desktop/Chordata%20Verma%20college.pdf>

**SEMESTER II**  
**CORE LAB COURSE: CHORDATA**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								Internal	External	Total
ZU232CP1	-	-	2	-	2	2	30	25	75	100

**Pre-requisite**

Students should know the taxonomical classification of chordates in relation to their functional morphology.

**Learning Objectives**

1. To identify the structures and distinct features of phylum Chordata
2. To distinguish the characteristic features of each subphylum and class

**Course Outcomes**

On the successful completion of the course, student will be able to:		
1	identify and recall the name and distinct external and internal features of animals belonging to phylum Chordata.	<b>K1</b>
2	explain the structural organization of various organs and systems in different classes of vertebrates.	<b>K2</b>
3	analyze, compare, and distinguish the morphological features and developmental stages of chordates	<b>K3</b>

**K1** - Remember; **K2** - Understand; **K3** – Apply

Units	Contents	No. of Hours
I	<b>Dissections:</b> Frog (Demo): External features, Digestive system, Arterial system, 5 <sup>th</sup> Cranial nerve, 9 <sup>th</sup> and 10 <sup>th</sup> cranial nerves.	6
II	<b>Mounting:</b> Fish: Placoid and Ctenoid scales, Frog: hyoid apparatus and brain (Demo).	6
III	<b>Osteology:</b> Frog: skull, vertebral column, pectoral girdle, pelvic girdle, Forelimb, hindlimb. Chelonia - anapsid skull. Pigeon – skull, synsacrum.	6
IV	<b>Specimen and Slides:</b> Balanoglossus, Tornaria larva, Amphioxus, Petromyzon, Ammocoetus larva. Pisces: <i>Torpedo</i> , <i>Channa</i> , <i>Hippocampus</i> , <i>Exocoetus</i> , <i>Echieneis</i> , <i>Catla</i> , <i>Clarius</i> . Scales: placoid, cycloid, ctenoid Amphibia: Ichthyophis, , Bufo, Axolotl larva Reptilia : <i>Draco</i> , <i>Chamaeleon</i> , <i>Gecko</i> , <i>Uromastix</i> , <i>Viperarusselli</i> , <i>Naja</i> , <i>Enhydrina</i> , <i>Typhlops</i> <i>Trionyx</i> , <i>Crocodylus</i> , Aves: <i>Psittacula</i> , <i>Bubo</i> , <i>Corvus</i> , <i>Pavo</i> ; Collection and study of different types of feathers: Quill, Contour, Filoplume,	8

	Down Mammalia: Ornithorhynchus, Tachyglossus, Pteropus, Funambulus, Loris, Hedgehog	
V	Embryology: Life cycle of Frog - Placenta in mammals.	4

### Text Books

1. Lal S. 2009. *Practical Zoology Vertebrate*, Rajpal and Sons Publishing, New Delhi.
2. Verma P. S, 2000. *A Manual of Practical Zoology: Chordates*, S. Chand Limited. New Delhi.

### Reference Books

1. Robert William Hegner, 2015. *Practical Zoology*, Biblio Life. Macmillan London.
2. Young, J, Z., 1972. *The life of Vertebrates*. Oxford University. London.
3. Kotpal, R.L. A, 2009. *Modern text book of Zoology Vertebrates-* Rastogi publications.  
Meerut, U.P.

### Web Resources

1. <https://bit.ly/3CzTEy8>
2. [https://www.youtube.com/watch?v=b04hc\\_kOY10](https://www.youtube.com/watch?v=b04hc_kOY10)
3. <http://tolweb.org/Chordata/2499>
4. <https://www.nhm.ac.uk/>
5. <https://bit.ly/3Av1Ejg>

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
<b>CO1</b>	3	2	2	3	3	2	3	3	2	2	2	3
<b>CO2</b>	3	1	2	2	2	2	3	2	2	2	1	2
<b>CO3</b>	3	2	1	2	2	1	3	2	1	1	1	2
<b>TOTAL</b>	9	5	5	7	7	5	9	7	5	5	4	7
<b>AVERAGE</b>	3	1.6	1.6	2.3	2.3	1.6	3	2.3	1.6	1.6	1.3	2.3

**3 – Strong, 2- Medium, 1- Low**

**SEMESTER II**  
**ELECTIVE COURSE II: ALLIED ZOOLOGY II**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU232EC1	-	4	-	-	3	4	60	25	75	100

**Prerequisite**

Students should be known about structure and role of body organs, development, inheritance, immunity against diseases and behavioral aspects of animal.

**Learning Objectives**

1. To impart knowledge on Physiology, Immunology, Genetics and Animal behavior.
2. To instill interdisciplinary skills for availing employment opportunities.

**Course Outcomes**

On the successful completion of the course, student will be able to:		
1.	recall the internal parts and developmental stages, patterns of inheritance and different types of animal behavior.	<b>K1</b>
2.	recognize the major functions of organ and immune systems in the human body and their role and analyze the stages of development in frog.	<b>K2</b>
3.	correlate the physiological processes of animals and relationship of organs system, inheritance of characters.	<b>K3</b>

**K1** - Remember; **K2** - Understand; **K3** - Apply

Units	Contents	No. of Hours
I	Physiology: Respiration- Respiratory pigments and transport of gases. Structure and functions of lungs. Mechanism of blood clotting. Types of excretory products – ornithine cycle. Structure of neuron– Conduction of nerve impulse, Mechanism of vision and hearing.	12
II	Developmental Zoology: Structure of sperm and ovum (human). Fertilization (sea urchin), Cleavage: types, blastulation, gastrulation and organogenesis of Frog; Placentation in mammals.	12
III	Immunology: Immunity – types of immunity. innate and acquired - active and passive; Antigens and Antibodies; Immunological organs and cells – responses in humans – innate ad acquired immunity - vaccination schedule.	12
IV	Human Genetics: Human Chromosomes – Sex Determination in Humans; Patterns of Inheritance: Autosomal Dominant, Autosomal Recessive, X-linked, Y-linked, ABO blood typing. Multiple Allelic	12

	and Polygenic; Genetic Counselling	
V	Animal Behaviour: foraging, display, courtship, alarming behaviour, Communication in insects, Shelter and Nest Construction, Parental Care, Learning Behaviour.	12

<b>Self-study</b>	Biological Rhythms, Immune cells.
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### Textbook

1. Verma P. S .and Agarwal V K 2018. *Developmental Biology, Chordata embryology*. S. Chand & Co., India
2. Chaki, K K, Kundu, G, Sarkar, S 2011. *Introduction to General Zoology: Volume I*. new Central Book Agency, India.

### References Books

1. Owen, J. A., Punt, J. & Stanford, S. A. 2013. *Kuby Immunology*. New York: W.H. Freeman & Company
2. Klug, W. S., Cummings, M. R. & Spencer, C. 2019. *Concepts of Genetics*. (12th ed.). New Jersey: Pearson Education
3. Mathur, R. 2005. *Animal Behaviour*. Meerut: Rastogi Publications, Meerut, Uttar Pradesh.
4. Verma P.S. & Agarwal- *Developmental Biology, Chordata embryology* S. Chand & Co., India.
5. Subramanian. M.A. 2019. *Developmental Zoology*. MJP Publishers, India.

### Web Resources

1. <https://www.onlinebiologynotes.com/nerve-impulse-conduction/>
2. <https://www.onlinebiologynotes.com/physiology-of-vision/>
3. <https://www.onlinebiologynotes.com/developmental-biology-of-frog-embryonic-development/>
4. <https://www.cdc.gov/vaccines/schedules/hcp/imz/child-adolescent.html>
5. [https://www.youtube.com/watch?v=b04hc\\_kOY10](https://www.youtube.com/watch?v=b04hc_kOY10)

### MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
<b>CO1</b>	1	2	2	2	1	2	2	3	2	2	2	3
<b>CO2</b>	1	1	1	2	2	2	2	2	2	2	1	2
<b>CO3</b>	2	2	2	3	3	2	3	3	2	2	2	3
<b>TOTAL</b>	4	5	5	7	6	6	7	8	6	6	5	8
<b>AVERAGE</b>	1.3	1.6	1.6	2.3	2.2	2.2	2.3	2.7	2.2	2.2	1.6	2.7

3 - Strong; 2 - Medium; 1 - Low



**SEMESTER II**  
**ELECTIVE LAB COURSE II: ALLIED ZOOLOGY II**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU232EP1	-	-	2	-	2	2	30	25	75	100

**Pre-requisite:**

Students should be aware of surrounding living invertebrates and vertebrates and their basic structural differentiations and their habitats.

**Learning Objectives**

1. To develop practical skills in basic concepts of biology.
2. To foster a deeper understanding of fundamental biological principles.

**Course Outcomes**

On the successful completion of the course, student will be able to:		
1.	recognize museum specimens, stages of cleavage, vital organs, genetic diseases of human.	<b>K1</b>
2.	explain the economic importance of animals, clinical procedures, dominant and recessive characters of humans.	<b>K2</b>
3.	use the skills relevant to basic and applied Zoology for identification and differentiation of animal forms.	<b>K3</b>

**K1** - Remember; **K2** - Understand; **K3** – Apply

**Experiments**

1. Chick embryo 24, 48 & 72 hrs (Mounting)
2. Identification of blood groups.
3. Simple Mendelian traits in man.
4. Test for excretory products in animals
5. Mounting of frog's egg.
6. Model making of nest.

**Spotters:** Haemoglobin, ornithine cycle, Neuron, Frog's egg, Gastrula of frog, Human Placenta, Immunoglobulin, Thymus, Human karyosome, Down's syndrome, Bird's nest, Parental care (fish & birds) - Pouched mammals (Kangaroo & Koala).

**Virtual laboratory / CD can be used as and when necessary.**

**MAPPING WITH PROGRAMME OUTCOMES**  
**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2	3	2	3	3	2	2	1
CO2	2	1	1	1	2	3	2	3	2	3	3	1
CO3	3	2	1	2	1	2	2	3	2	2	2	2
<b>Total</b>	8	5	4	6	5	8	6	9	7	7	7	4
<b>Average</b>	2.7	1.6	1.3	2.2	1.6	2.7	2.2	3	2.3	2.3	2.3	1.3

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

**SEMESTER II**  
**NON-MAJOR ELECTIVE NME II**  
**BIOCOMPOSTING FOR ENTREPRENEURSHIP**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU232NM1	-	1	1	-	2	2	30	25	75	100

**Pre-requisite**

Students should aware about the effect of chemical pollution and the importance of organic farming.

**Learning Objectives:**

1. To highlight the importance of Bio composting for entrepreneurship in waste management.
2. To enable students for setting up Bio compost units and bins for waste reduction.

**Course Outcomes**

<b>On the successful completion of the course, students will be able to:</b>		
1.	define the process of bio composting by earthworms and explain the economic cost of establishing small Biocompost units as a cottage industry.	<b>K1</b>
2.	demonstrate composting techniques for various applications like solid waste management, industrial waste recycling using sugarcane bagasse, etc	<b>K2</b>
3.	establish a small Biocompost units as a cottage industry.	<b>K3</b>

**K1- Remember; K2- Understand; K3- Apply**

Units	Contents	No. of Hours
I	Biocomposting – Definition, types; home composting, vermicomposting, aerobic composting, anaerobic composting. Compost Ingredients - ecological importance.	6
II	Biocomposting technology: Field pits - ground heaps – tank - large-scale - batch and continuous methods – biology of the composting process. Humification of organic material. .Compost enrichment.	6
III	Methods of composing - Preparation of Biocompost pit and bed for Bangalore method, Indore method, Coimbatore method, NADEP method .	6

IV	Applications of Biocompost in soil fertility maintenance, promotion of plant growth, value added products, waste reduction, etc. Drawbacks of using composts.	6
V	Economics of establishment of a small biocompost unit – project report proposal for Self Help Group (Income and employment generation).	6

<b>Self-study</b>	Biocomposting – Definition, types and ecological importance.
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### Text Books

1. SeethaLekshmy, M. and Santhi. R, 2012. *Vermitechnology*. Nagercoil: Saras Publications, Nagercoil.
2. Mary Violet Christy. A, 2008. *Vermitechnology*. MJP Printers and Publishers Pvt. Ltd., Chennai.

### References

1. Bikas R. Pati & Santi M. Mandal, 2019. Recent trends in composting technology. IK International Publishing House Pvt. Ltd.
2. Dohama, A.K, 2004. *Vermicompost*, New Delhi: Vivekananda Kendra (NARDEP), Kaakumari.
3. Dahama, A.K, 2009. *Organic farming for sustainable Agriculture* (2<sup>nd</sup>ed.). Agrobios. Jodhpur
4. Sultan Ahmed Ismail, 2005. *The Earthworm* (2<sup>nd</sup>ed.): Other India Press, Goa
5. Gupta, P.K, 2003. *Vermicomposting for sustainable Agriculture*. Agrobios, Jodhpur.

### Web Resources

1. <https://www.dhsgsu.edu.in/images/Community-College/02-COMPOSTING-TECHNIQUES.pdf>
2. <https://www.trustbasket.com/blogs/composting/methods-of-composting-indoor-method-bangalore-method-coimbatore-method-nadep-method>
3. <https://aggie-horticulture.tamu.edu/earthkind/landscape/dont-bag-it/chapter-2-composting-fundamentals/>
4. [https://www.brainkart.com/article/Composting\\_35265/](https://www.brainkart.com/article/Composting_35265/)
5. <https://www.epa.gov/recycle/composting-home>

### MAPPING WITH PROGRAMME OUTCOMES MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
<b>CO1</b>	3	2	1	3	2	3	2	3	3	2	3	2
<b>CO2</b>	3	1	1	3	2	3	2	3	3	2	2	3

<b>CO3</b>	3	2	2	2	2	2	2	2	2	3	2	2
<b>TOTAL</b>	6	5	4	8	6	8	6	8	8	7	7	7
<b>AVERAG E</b>	2.2	1.6	1.3	2.7	2.2	2.7	2.2	2.7	2.7	2.3	2.3	2.3

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

**SEMESTER II**  
**SKILL ENHANCEMENT COURSE SEC-1**  
**ANIMAL BEHAVIOUR**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZU232SE1	1	1	-	-	2	2	30	25	75	100

**Prerequisite**

Students should have the basic understanding of animal biology, strong observational and analytical skills.

**Learning Objectives**

1. To understand the biological properties of animal behavior, with an evolutionary and ecological emphasis
2. To develop practical skills related to studying and analyzing animal behavior.

**Course Outcomes**

<b>On the successful completion of the course, students will be able to:</b>		
1.	Gain a comprehensive understanding of the key concepts related to the genetics, evolution, perception, learning, decision making and chronobiology of animal behaviour.	<b>K1</b>
2.	explain the evolutionary and ecological factors influencing social behaviour, the complexity of decision-making process in animals and the concepts of biological clocks.	<b>K2</b>
3.	interpret animal behaviour patterns, social behaviour dynamics, predict and manage animal physiology and behaviour, solve behavioural problems, optimise human health and well-being.	<b>K3</b>

**K1-** Remember; **K2-** Understand; **K3-** Apply

Unit	Contents	No. of hours
I	<b>Basics of Animal Behaviour</b> : Defining animal behaviour, Importance and significance of studying animal behaviour, Approaches to behavioural studies, Genetic basis of behaviour, Heritability of behaviour, Habitat and its impact on influencing behaviour, Social interactions and their role in shaping behaviour, Ethology and recording animal behaviour.	6
II	<b>Evolution and Social Behaviour:</b> Natural selection and Social Behaviour, Sexual selection, Altruism, Mating systems and Sexual strategy and social organisation, Animal perception, Communication in Social animals, Group living, Parental Care, Visual adaptations to	6

	unfavourable environments.	
III	<b>Animal and the Environment:</b> Habitat selection, Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Conditioning and Learning, Biological aspects of learning, Cognitive aspects of learning. Foraging behaviour, Competition, Environmental challenges and stressors.	6
IV	<b>Understanding Complex Behaviour:</b> Instinct, learning, Cognition and Memory, Decision making behaviour in Animals, Mechanism of Decision making, Complex reproductive behaviours, Complex behaviour of honey bees, Languages and mental representation, Animal awareness and Emotion.	6
V	<b>Chronobiology:</b> Circadian rhythm, Biological Clock, concept of central and peripheral clock system; circadian pacemaker system; photoperiodism, Influence of circadian rhythms on mating, feeding, and other behaviours, Ultradian and Infradian Rhythms, Chronobiology and Aging, Chrono pharmacology, chrono medicine, chronotherapy.	6

<b>Self-study</b>	Parental Care, Homeostasis
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### Textbook

1. Agarwal, V.K, 2009. *Animal Behaviour (Ethology)*. S. Chand and Company Ltd., New Delhi.
2. Saha T. K, 2009. *An Introduction to Animal behaviour*. Emkay Publications, New Delhi.

### Reference Books

1. Sanjib Chattopadhyay 2012. *LIFE: Evolution, Adaptation and Ethology*. Books and Allied (P) Ltd., Kolkata
2. Chandrashekar, M.K, 1985. *Biological Rhythms*. Madras Science Foundation, Chennai.
3. Mohan P. Arora, 2016. *Animal Behavior*. Himalaya Publishing House. Chennai.
4. Auprey Manning and Mariam Stamp Dowkins, 2012. *An Introduction to Animal behavior*. Cambridge University Press. UK.
5. Machve K. K, 2016. *Evolution of Animal Behaviour*. Manglam Publications. Thiruvananthapuram

### Web Resources

1. <https://www.ncbs.res.in/content/animal-behaviour>
2. <https://bit.ly/3i6wUxR>
3. <https://www.behaviour.univie.ac.at/>
4. <https://www.ru.nl/bsi/>

5. [http://www.apiindia.org/pdf/progress\\_in\\_medicine\\_2017/mu\\_75.pdf](http://www.apiindia.org/pdf/progress_in_medicine_2017/mu_75.pdf)

**MAPPING WITH PROGRAMME OUTCOMES**  
**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	2	3	2	3	2	3	3	2	3	2
CO2	3	1	2	3	2	3	2	3	3	2	2	3
CO3	3	2	1	2	2	2	2	2	2	3	2	2
<b>Total</b>	9	5	5	8	6	8	6	9	8	7	7	7
<b>Average</b>	3	1.6	1.6	2.7	2	2.7	2	3	2.7	2.3	2.3	2.3

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

	<b>Content addressed with Local Needs</b>
	<b>Content addressed with National Needs</b>
	<b>Content addressed with Regional Needs</b>
	<b>Content addressed with Global Needs</b>

## M.Sc. Syllabus (2017 Board)

### Semester I

#### Core I - Biochemistry

Course Code: PZ1711

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

#### Objectives

1. To create awareness among the students about the structure and functions of biomolecules.
2. To provide knowledge in tackling more advanced and specialized biochemical techniques.

#### Course Outcomes

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	assess the relationship between chemistry, physics and biology.	PSO - 1	E
CO - 2	recognize the structure and functions of biomolecules.	PSO - 1	R
CO - 3	discuss basic principles of metabolism and associated metabolic diseases.	PSO - 7	U
CO - 4	demonstrate experiments and techniques related to biochemistry.	PSO - 2	Ap; An
CO - 5	gain employability in industrial, biomedical and research laboratories.	PSO - 9	Ap

**UNIT I** Atoms – Molecules – Chemical bonds – Primary bonds and secondary bonds – pH and Hydrogen ion concentration – Buffers – ‘Henderson-Hasselbalch’ equation – Buffer systems in blood - Mechanism of buffer action - Acid base balance – Regulation of acid base balance – Acidosis and Alkalosis. Water – Colligative properties – Water turnover and balance – Electrolyte balance – Dehydration and Water intoxication.

**UNIT II** **Carbohydrates:** Classification, structure, properties of mono, oligo and polysaccharides and biological role of carbohydrates - Carbohydrate metabolism - glycogenesis, glycogenolysis, glycolysis, Krebs cycle, Electron transport and Oxidative phosphorylation, Energetics of glucose metabolism - Pasteur effect–HMP shunt - gluconeogenesis – glyoxylate pathway – Cori cycle – Regulation and hormonal control of carbohydrate metabolism – glycogen storage diseases – blood sugar level – Glycosuria - Glucose tolerance test – Diabetes.

**UNIT III** **Proteins:** Classification, structure, Ramachandran plot, Properties and biological role. Amino acids - classification, structure and properties – Metabolism of proteins - deamination, transamination– transmethylation and decarboxylation of amino acids – glycolytic and ketogenic amino acids – Formation and transport of ammonia - glucose-alanine cycle - Ornithine cycle – Metabolism of Phenylalanine, Tyrosine and Tryptophan. Porphyrins.

**UNIT IV**



**Lipids:** Classification, structure and Biological role - Chylomicrons, VLDL, LDL, HDL - Lipid metabolism – Theories of oxidation of fatty acids – Oxidation of any one fatty acid and its bioenergetics (palmitic acid) – Ketogenesis - Biosynthesis of palmitic acid – Metabolism of cholesterol - lipid storage diseases – Role of liver in fat metabolism. Prostaglandins. Integration of carbohydrate, protein and lipid metabolism.

**UNIT V Nucleotide metabolism:** Biosynthesis and degradation of purines and pyrimidines. **Enzymes:** classification, nomenclature, enzyme kinetics, Michaelis - Menten constant, enzyme inhibition, mechanism of enzyme action, factors affecting enzyme activity, isozymes, coenzymes. **Vitamins:** Classification (fat soluble and water soluble), occurrence and biochemical role. **Detoxification:** Mechanism of detoxification (oxidation, reduction, conjugation) - cytochrome P 450 system.

#### Reference Books

1. Satyanarayana, U. & Chakrapani, U. (2013). Biochemistry (4<sup>th</sup> ed). India: Elsevier.
2. Chatterjea, M.N. & Rana Shinde (2012). Textbook of Medical Biochemistry (8<sup>th</sup> ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
3. Vasudevan, D. M., Sree Kumari, S. & Kannan Vaidyanathan (2013). Textbook of Biochemistry for Medical Students (7<sup>th</sup> ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Limited.
4. Nitin Jain, Jain, J.L. & Sunjay Jain (2014). Fundamentals of Biochemistry. S. Chand & Co. Ltd., New Delhi.
5. Jeremy M. Berg, John L. Tymoczko & Lubert Stryer (2006). Biochemistry (6<sup>th</sup> ed.). San Francisco: Freeman & Co. Publishers.
6. Ambika Shanmugam (2012). Fundamentals of Biochemistry for Medical Students (7<sup>th</sup> ed.). Published by Wolters Kluwer, India.
7. David L. Nelson & Michael M. Cox (2004). Lehninger Principles of Biochemistry (4<sup>th</sup> ed.). New York: W.H. Freeman and Company.

**Semester I**  
**Core II - Cell and Molecular Biology**  
**Course Code: PZ1712**

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	4	90	100

**Objectives**

1. To provide firm intellectual and basic knowledge on the structure and functions of biomembranes, cell organelles and molecules of eukaryotic cells.
2. Get employment in educational institutions and research laboratories.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	recognize and describe the structural and functional organization of cell organelles.	PSO - 1	U
CO - 2	illustrate dna replication and trace the flow of genetic information from dna to protein, protein sorting and trafficking	PSO - 4	Ap
CO - 3	summarise the cell cycle and proteins involved in the regulation and molecular defects leading to cancer.	PSO - 5	U
CO - 4	identify signaling components and pathways.	PSO - 3	U
CO - 5	apply the principles and techniques of molecular biology for further education and employment.	PSO - 6	Ap

**UNIT I Cell Structure & Functions of cell organelles:** prokaryotic cells – structure. Plasma membrane: Structure and function - active transport and pumps- transport by transporter proteins – membrane potential. Cell – cell and cell – matrix interaction: Cell adhesion molecules: Selectin – Integrin – Cadherins. Calcium dependent and Calcium independent homophilic cell–cell adhesion. Tight junction, Gap junction – connexin. Extracellular matrix – Collagen and non–collagen components.

**UNIT II Cell Signaling:** Extra cellular signaling – signaling molecules and their receptors - Functions of cell surface receptors. Pathways of intracellular signal transduction: G protein coupled receptors – Cyclic AMP pathways - Receptor Tyrosine Kinases (RTKs) – Ras, Raf and MAP kinase pathway – second messengers – signaling from plasma membrane to nucleus.

**UNIT III Cell organelles and Nucleic acids:** Structure and functions of Nucleus, Mitochondria, Endoplasmic reticulum - Golgi complex and lysosomes. Cytoskeleton – structure and functions. Ribosomes and translation of genetic information - Types, structure and functions of RNA.

**UNIT IV Protein synthesis and transport:** DNA template – – Transcription – Translation – Post translation detection. Protein – Protein trafficking - sorting: Secretory and endocytic pathway – transport from endoplasmic reticulum to Golgi – Anterograde and retrograde transport – transport to lysosome – exocytosis – endocytosis. Membrane protein and secretory proteins.

**UNIT V Normal and abnormal cell growth and functions:** Cell cycle – Mitosis - Meiosis - Cyclin and Cyclin dependent kinases – Regulation of cyclin dependent kinases (cdk) – Cyclin activity. Biology of ageing – role of anti-oxidants and free radicals. Apoptosis – definition – mechanism and significance. Neoplastic transformation: cancer – proto-oncogenes – tumour suppressor genes.

#### **Reference Books**

1. Lodish, H. & Berk, A. (2016). Molecular Cell Biology (8<sup>th</sup> ed.). New York: W.H. Freeman and Company Limited Publication.
2. Gupta, P.K. (2014). Cell and Molecular Biology (4<sup>th</sup> ed.). New Delhi: Rastogi Publication.
3. Geoffrey M. Cooper & Robert E. Hausman (2013). The cell: A Molecular Approach (6<sup>th</sup> ed.). Massachusetts, USA: Sinauer Associates Publication.
4. Alberts B., Johnson. A., Lewis, J., Raff, M., Roberts, K. and Watter, P. (2008). Molecular Biology of the Cell (5<sup>th</sup> ed.). New York: Garland Science Publication.
4. De Robertis, E.D.P. (2011). Cell and Molecular Biology (8<sup>th</sup> ed.). New York: Lippincott Williams & Wilkins Publication.

**Semester I**  
**Core III - Culture and Capture Fisheries**  
**Course Code: PZ1713**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To gain knowledge on the construction and maintenance of ponds for culture of different types of cultivable aquatic organisms and also to gain information on fishery management, fish processing, preservation techniques and parasites of fishes.
2. To raise aqua farming and extend it to the society.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	acquire knowledge on different types of aquatic organisms and construction of ponds.	PSO - 6	U
CO - 2	formulate the nutritional requirement of fishes and develop the breeding techniques.	PSO - 4	C
CO - 3	explain the culture of finfish and shellfish and identify the diseases and control measures.	PSO - 6	U; Ap
CO - 4	gain knowledge on fishery genetics and transgenic fishes.	PSO - 7	U
CO - 5	identify fish resource, capture techniques and fish marketing.	PSO - 6	U
CO - 6	develop entrepreneurship skill by employing fish processing techniques.	PSO - 9	Ap

**UNIT I Purpose and importance of aquaculture - basic qualification of candidate species - cultivable freshwater and marine fishes - global and Indian scenario of aquaculture. Construction and maintenance of fish farm: selection of site - lay-out and types of ponds - aquatic plants and their control - control of fish predators - liming - fertilization of ponds. Kinds of aquaculture - Integrated fish farming - Sewage fed fish culture - Pen and cage culture.**

**UNIT II Nutrition and Breeding: Nutritional requirements - Culture of fish feed organisms - phytoplankton (diatom), zooplankton (rotifers, cladocerans), Artemia, Tubifex. Artificial feed and feed formulation. Seed collection: Sex identification – collection, rearing and selection of brooders - induced breeding by hypophysation - ovaprim - transportation of fish seed.**

**UNIT III Finfish culture: Culture of Indian major carps, Tilapia and murrel. Ornamental fish culture and its prospectus. Shell fish culture: Culture of freshwater and marine prawns, lobsters, crabs, edible and pearl oysters. Fish pathology: Ectoparasites, Endoparasites, Bacterial, Viral and Fungal diseases, nutritional deficiency diseases.**

**UNIT IV Fishery Genetics: Chromosomes in fishes - chromosome set manipulation - gynogenesis and androgenesis - induced polyploidy. Chromosomal abnormalities - Sex**

determination in fishes - sex patterns - intrinsic and extrinsic factors in sex control and sex reversal. Transgenic fishes.

**UNIT V Capture Fisheries:** Inland fisheries (riverine, lakesterine and cold water fisheries) - Estuarine fisheries - Marine fisheries, Crafts and fishing gears - Common fishes of Kanyakumari - Fish spoilage and methods of fish preservation – Fish Marketing and co-operative societies in aquaculture. **Economic importance of fishes:** Food value and fish by-products.

#### **Reference Books**

1. Pillay, T.V.R. (1990). Aquaculture: Principles and Practices. England: Fishing News Books Ltd.
2. Khanna, S.S. (2005). An Introduction to fishes. Allahabad: Silverline Publications.
3. Pandey & Shukla (2005). Fish and Fisheries. Meerut: Rastogi Publications.
4. Jai Singh, P. (2008). Fishes of Kanyakumari – A Hand Book on the Study of Fishes (2<sup>nd</sup> ed.). Nagercoil: Tower Graphics Printer.
5. Bardach, J. (1972). Aquaculture. New York: Wiley-Interscience Publication.
6. Jhingran, V.G. (1991). Fish and Fisheries of India. New Delhi: Hindustan Publishing Co.
7. Schaperclaus (2001). Fish Diseases, Vol. I and II. New Delhi: Oxonian Private Ltd.
8. Ghosh, R. (2007). Fish Genetics and Endocrinology. New Delhi: Swastik Publishers.
9. Santhanam, R. (1990). Fisheries Science. New Delhi: Daya Publishing House.
10. Rath, R.K. (1993). Freshwater Aquaculture. Jodhpur: Scientific Publishers.
11. Schonder. S.L. (1980). Hypophysation in Indian Major Carp. Agra: Satish Book Enterprises.
12. Reddy, P.V.G.K., Ayyappan, S., Thampy, D.M. & Gopal Krishna (2005). Text book of Fish genetics and Biotechnology. New Delhi: Indian Council of Agricultural Research.

**Semester I**  
**Elective I – (a) Biosystematics and Biodiversity**  
**Course Code: PZ1714**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To enable the students to know about the diversified forms in nature and also to identify the relationships among different species.
2. Get employability in Zoological Survey of India, Museum and Biodiversity conservation organizations.

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	evaluate the importance, application, and practice of systematic biology.	PSO - 1	U; Ap
CO - 2	outline the classification of animal kingdom.	PSO - 1	R; E
CO - 3	collect, identify, preserve zoological specimens and assign systematic position based on international code of zoological nomenclature.	PSO - 2	Ap; An
CO - 4	discuss the importance of biodiversity and its conservation.	PSO - 9	An; Ap
CO - 5	assess the biodiversity and use library resources in biological research.	PSO - 2	E; Ap

**UNIT I** Basic concepts of Biosystematics - Importance and applications of biosystematics - Stages of taxonomy – alpha, beta and gamma taxonomy. Newer trends in taxonomy: Morphological, embryological, ecological, behavioral, cytological, biochemical approaches, Numerical taxonomy and Molecular taxonomy.

**UNIT II Zoological classification:** Theories of classification, components of classification, Linnaean hierarchy. Outline classification of animal kingdom. Systematic position of Invertebrates (one example for each phylum) and Chordates (one example for each class). Concept of species: kinds of species concept, polytypic species, sub species and other infra specific groups. Super species.

**UNIT III Taxonomic collection:** Collecting ways, preservation of collected materials, curating, preparation of specimens and methods of identification. **Zoological Nomenclature:** International code of Zoological Nomenclature (ICZN) – rules of nomenclature. Typification, type and its kinds.

**UNIT IV Biodiversity and its conservation:** Importance of biodiversity. Human impact on biological diversity: habitat fragmentation – wild life and human conflict - loss of animal diversity - endangered wildlife species – special projects - IUCN red list - hot spots. Conservation of biodiversity: In situ and Ex situ conservation - management of germplasm.

Conservation practices in India: Wildlife sanctuaries, national parks and biosphere reserves - Indian Board of Wildlife (IBWL) - wildlife protection laws – Trade laws (CITES).

**UNIT V Biodiversity – Levels of diversity – species, genetic, ecosystem. Evaluation of Biodiversity indices: Shannon-Weiner index, Brillouin diversity index, Dominance index (Simpson and Margalef index), Evenness index, richness index, Similarity and dissimilarity index, Association index. Diversity and ecosystem process theory.**

#### **Reference Books**

1. Kapoor, V.C. (2001). Practice of Animal Taxonomy (5<sup>th</sup> ed.). New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
2. Simpson, G.G. (1969). Principles of Animal Taxonomy. New Delhi: Oxford and IBH Publishing Co.
3. Supriyo Chakraborty (2004). Biodiversity. Jaipur: Pointer Publishers.
4. Jordan, E.L. & Verma, P.S. (2001). Invertebrate Zoology. New Delhi: S. Chand and Company Ltd.
5. Jordan, E.L. and Verma, P.S. (2014). Chordate Zoology. New Delhi: S. Chand and Company Ltd.
6. Trivedi, P.C. and Sharma, K.C. (2003). Biodiversity Conservation. Jaipur: Avishekar Publishers.
7. Kotpal, R.L. (2014). Modern Text Book of Zoology, Invertebrates. Meerut, New Delhi: Rastogi Publications,
8. Kotpal, R.L. (2005). Modern Text Book of Zoology, Vertebrates (3<sup>rd</sup> ed.). Meerut, New Delhi: Rastogi Publications.
9. Ekambaranatha Ayyar, M. & Anantha Krishnan, T.N. (1985). Manual of Zoology, Volume I, Invertebrata. Chennai: Viswanathan Printers and Publisher Pvt. Ltd.
10. Ekambaranatha Iyyar, M. (1995). A Manual of Zoology, Volume II, Chordata. Chennai: Viswanathan Printers and Publisher Pvt. Ltd.
11. Kato, M. (2012). The biology of biodiversity. Tokyo: Springer – Verlag Publications.

**Semester I**  
**Elective I - (b) Cell Technology**  
**Course Code: PZ1715**

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To apply certain biological techniques to observe and analyze cells and their constituents in health and disease.
2. To impart skills to perform histological and histochemical techniques and identify the types of cells and their products.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain isolation, culture, harvest and preservation of cell.	PSO - 1	U
CO - 2	prepare tissues for microtechnique and identify stains to distinguish histological and histo-chemical preparations.	PSO - 6	R; Ap
CO - 3	apply differential staining technique for identification of diseases.	PSO - 4	Ap
CO - 4	analyse the applications of stem cell technology and tissue engineering.	PSO - 9	An
CO - 5	apply theoretical knowledge of cell manipulation techniques in research.	PSO - 4	Ap

**UNIT I** Cells as experimental models – microorganisms (*E. coli* and Yeast), invertebrates (*Caenorhabditis elegans* and *Drosophila melanogaster*), vertebrates (*Xenopus* and mice) - Isolation, culture, harvest and preservation of cells – cryopreservation of cells for later recovery- plasmolysis, hemolysis and cell fractionation.

**UNIT II** Tissue preparation for microtechnique – fixation – need, types and a good fixative – preparation of compound fixatives – physical and chemical effects of fixation – alternative methods of fixation- special treatment of mineralized tissue - processing – embedding and sectioning.

**UNIT III** Staining – definition of a stain – structure and classification of stains - principles and properties of staining – vital staining – metallic impregnation technique use of radiolabelled and Fluorescent dye. Stains: histological, acidophilic, basophilic and histochemical. Alizarin preparation. Significance of staining – Blood dyes.

**UNIT IV** Histochemistry – principles of commonly used histochemical techniques. Identification and demonstration of tissue components – proteins, carbohydrates, lipids, nucleic acids, enzymes, pigments, amyloids. Differential staining in identification of pathogens and diagnosis of disease.

**UNIT V** Stem cell technology – Stem cells - properties, applications and current standings of the stem cell technology. Embryonic stem cell – adult stem cell – applications – Stem-cell



plasticity, Regulators of pluripotency and differentiation of stem cell. Regenerative medicine – Current stem cell therapies - stem cells and ageing - clinical applications of hematopoietic stem cells from cord blood - treatment of neural diseases such as Parkinson's disease, Huntington's disease and Alzheimer's disease. Repair of damaged organs (liver and pancreas).

#### Reference Books

1. John R. Baker (1966). *Principles of Biological microtechnique - A study of fixation and dyeing*. Great Britain: Richard Clay and Company Pvt. Ltd.
2. Ramnik Sood (1994). *Medical Laboratory Technology* (4<sup>th</sup> ed.). New Delhi: Jaypee Brothers Medical Publishers Pvt. Ltd.
3. Gretchen, L.H. (1979). *Animal tissue techniques*. San Francisco: W.H. Freeman and Company.
4. Lodish, Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. & Darnell, J. (2000). *Molecular Cell Biology*. San Francisco: W.H. Freeman and Company.
5. Joseph Panno (2006). *Stem cell research - Medical applications and ethical controversy*. USA: Checkmark Books Publication.
6. Shyamsundari, K & Hanumantha Rao (2007). *Histochemistry in focus: A source book of techniques and research needs*. Chennai: MJP Publishers.
7. Prakash, M. & Arora, C.K. (1998). *Microscopical methods in Encyclopaedia of laboratory techniques series*. New Delhi: Anmol Publication Pvt. Ltd.

**Semester I**  
**Practical I (Biochemistry, Cell and Molecular Biology and Culture and Capture Fisheries)**  
**Course Code: PZ17P1**

No. of hours/week	No of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To design and perform biochemical and cell biological experiments.
2. To provide laboratory skills to identify the aquatic organisms and the physico-chemical parameters for sustainable aquaculture.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	estimate the biomolecules and demonstrate the bio-techniques.	PSO - 1	An
CO - 2	use the tools and techniques in cell biology.	PSO - 1	Ap
CO - 3	prepare temporary mounting of cell and tissues.	PSO - 1	Ap
CO - 4	assess the fish population and determine the age of fishes.	PSO - 2	Ap; E
CO - 5	identify the factors that challenge aquaculture.	PSO - 4,	An

**Biochemistry**

1. Colorimetry- verification of Beer-Lambert's law.
2. Determination of pH of the given sample using pH paper and pH meter.
3. Quantitative estimation of glucose (Blood/Tissue).
4. Quantitative estimation of protein.
5. Quantitative estimation of Total lipid (Blood/Tissue).
6. Quantitative estimation of ascorbic acid.
7. Quantitative estimation of blood urea.
8. Determination of salivary amylase activity in relation to temperature, pH and enzyme activity.
9. Chromatographic separation of amino acids.
10. Electrophoresis - SDS - PAGE (Demonstration).

**Instruments/ Charts/ Models**

Colorimeter, pH Meter, Centrifuge, Chromatogram, Electrophoretic unit

**Cell and Molecular Biology**

1. Isolation and observation of sub cellular organelles.
2. Observation of mitosis from onion root tip.
3. Observation of meiosis from grasshopper testis.
4. Observation of polytene chromosome from the salivary gland of
5. Chironomous larva.
6. Barr-body identification.
7. Observation of striated muscle fibre from the coxal muscle of cockroach.

8. Observation of adipocytes from the fat body of cockroach.

9. Haemolymph smear (Cockroach).

10. Blood smear (Human).

### **Spotters/ Slides:**

Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer.

### **Culture and Capture Fisheries**

1. Morphometry of a pond.

2. Estimation of fish population by Mark and Recapture method using beads.

3. Length- weight relationship of fish *Oreochromis mossambicus*.

4. Morphological features of penaeids and nonpenaeids.

5. Identification of aquatic weeds, insects and predators.

6. Sex identification in fishes and prawn.

7. Determination of age and growth in fishes (scales).

8. Fish pathology – White spot- Tail rot – Costiasis - Anchor worm- Saprolegnia

9. Taxonomic description of the following - Indian major carps: *Catla catla*, *Labeo rohita*, *Cirrhinus mrigala*. Exotic carp: *Cyprinus carpio*, Silver carp: *Hypophthalmichthys molitrix*. Grass carp: *Ctenopharyngodon idella*. Cat fishes: *Clarius batrachus*, *Heteropneustes fossilis*. Other cultivable fishes: *Channa punctatus*, *Channa morulius*. Prawns, lobsters, crabs and oysters.

1. Visit to a coastal / aquaculture research centre (report).

**Semester II**  
**Core IV - Biostatistics, Computer Applications and Bioinformatics**  
**Course Code: PZ1721**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To enable the students to get the insight into statistical analysis of biological data with mathematical principles in collection and calculations in various biological experiments.
2. To develop skill in handling useful tools for automation of complex computer jobs, and making these tools accessible on the network from a Web browser.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	choose appropriate sampling scheme and interpret biological data.	PSO - 2	U; R
CO - 2	formulate hypothesis and test the significance.	PSO - 4	Ap
CO - 3	apply the computer skills for biological data management and presentation.	PSO - 6	Ap
CO - 4	use database similarity search and retrieval tools in sequence analysis.	PSO - 8	C; Ap; An
CO - 5	develop skills in submitting molecular data to scientific community.	PSO - 9	U; Ap

**UNIT I** Population and sample in biological studies - variables - sampling methods. Types of biological data. Measurement scales - ratio scale, interval scale, ordinal scale, nominal scale - parameters and statistics. Accuracy and precision. **Data collection and presentation:** Tabulation - graphs - diagrams. Frequency distribution - histogram - frequency curves and Ogives. Measures of central tendency: types of mean, median, mode.

**UNIT II** **Measures of dispersion:** Range – quartile and percentile - mean deviation - standard deviation - coefficient of variation – skewness and kurtosis - standard error. **Distribution:** Binomial, Poisson and Normal. Parametric and non parametric tests. Hypothesis testing – single and two population mean - types of error (Type I and Type II) – Chi-square analysis – test for goodness of fit and homogeneity.

**UNIT III** Student's t-distribution - Analysis of variance (ANOVA): one way classification and two way classification (Factorial design). Probability: Addition theorem, multiplication theorem and conditional theorem. Permutation and combination. Correlation – types, methods of study and testing the significance. Regression: equations – regression lines – simple linear regression and testing its significance. Mathematical modeling in biology: types and applications.

**UNIT IV** **Computer applications:** Computer memory and storage devices (Hard disc, floppy disc, CD-ROM, DVD, Pendrive). Microsoft office - M.S. Power point. MS Excel and statistical function: Descriptive statistics – t –test, ANOVA, correlation, regression, Chi-square test, table and charts. Internet and E-Mail - viruses and worms. SPSS Package - usage and application.

**UNIT V Bioinformatics: Scope – Biological data bases – Data base retrieval tools (Locus link, ENTREZ, Pubmed and SRS) – Nucleotide sequence data base (NCBI, EMBL) - Protein data base (SWISS-PROT). Data base similarity research tools (BLAST, FASTA). Biological sequence analysis: sequence alignment, pair-wise alignment and multiple sequence alignment (CLUSTALW). Protein structure visualizing tools (RasMol, Swiss PDB Viewer). Applications of bioinformatics tools.**

**Reference books**

1. Gurumani, N. (2005). An Introduction to Biostatistics. Chennai: MJP Publishers.
2. Khan, I. & Khanum, A. (2014). Fundamentals of Biostatistics (3<sup>rd</sup> ed.): Hyderabad. Ukaaz Publications.
3. Zar, J.H. (1984). Biostatistical Analysis (2<sup>nd</sup> ed.). London: Prentice-Hall International Inc.
4. Bailey, N.T.J. (1997). Statistical methods in Biology (3<sup>rd</sup> ed.). New York: Cam. University Press.
5. Sokal, R. & James, F. (1973). Introduction to Biostatistics. Tokyo, Japan: W.H. Freeman and Company Ltd.
6. Daniel, W.W. (1987). Biostatistics: A foundations for Analysis in the Health Sciences. New York: John Wiley & Sons.
7. Gupta, S.P. (1998). Statistical Methods. New Delhi: S. Chand and Company Ltd.
8. Banerjee, P.K. (2005). Introduction to Biostatistics. New Delhi: S. Chand and Company Ltd.
9. Attwood, T.K & Parry Smith, D.J. (2005). Introduction to bioinformatics. Delhi: Pearson Education Pvt. Ltd.
10. John De Britto, A. (2011). Bioinformatics. Sivakasi: Anto Art Craft Printers.
11. Kumaresan, V., Arumugam, N., Gopi, A., Meena, A. & Sundaralingam, R. (2008). Biostatistics, Computer Application and Bioinformatics. Nagercoil: Saras Publication.
12. Sundaralingam, R. & Kumaresan, V. (2008). Bioinformatics. Nagercoil: Saras Publication.

**Semester II**  
**Core V - Genetics and Evolution**  
**Course Code: PZ1722**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To understand the principles of hereditary mechanisms at molecular level and to discern the evolutionary significance of animals.
2. To get employability in Genetic counseling units in hospitals and paleontological centers.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	apply the principles of inheritance as formulated by Mendel.	PSO - 2	U; Ap
CO - 2	identify the alterations in chromosome number and structure.	PSO - 7	R
CO - 3	explain the molecular and biochemical basis of genetic diseases.	PSO - 1	R
CO - 4	explain the key concepts in population, evolutionary and quantitative genetics	PSO - 1	U; An
CO - 5	discuss the mechanism of molecular evolution and origin of primates and hominids.	PSO - 5	U; R

**UNIT I Mendelian Genetics:** Mendelian principles (Dominance, segregation, independent assortment). Allelic and non-allelic interactions. Penetrance, expressivity and pleiotropism. Linkage and crossing over – types – mechanism – theories. Chromosome mapping - linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. LOD score linkage test. Polygenic inheritance. Heritability and its measurements. QTL mapping.

**UNIT II Molecular and Human Genetics:** Gene concept. Mutation – types and effects of gene mutation – mutagens – insertional mutagens. DNA damage and repair. Inter and Intra chromosomal aberrations. Ploidy - kinds – mechanism – significance. Human chromosomes, Karyotyping, Chromosomal banding and painting. Pedigree analysis. Inborn errors of metabolism: Disorders of amino acid metabolism (phenylketonuria, alkaptonuria, albinism), Disorders of nucleic acid metabolism (Gout, ADA deficiency), Disorders of carbohydrate metabolism (Pompe's, G<sub>6</sub>PD deficiency), Disorders of lipid metabolism (Tay Sach's disease, Gaucher's disease), Hemoglobin disorders (sickle cell anemia, thalassemia).

**UNIT III Population Genetics and Evolution:** Mendelian populations - gene pool and gene frequencies - Hardy Weinberg law and genetic equilibrium. Calculation of gene frequencies for autosomal (dominant and recessive alleles, codominant alleles and multiple alleles) and sex-linked genes. Factors affecting Hardy Weinberg equilibrium – selection - heterozygous advantage – mutation – migration – random genetic drift – Founder's effect. Genetic load and death - neutralist hypothesis - genetic polymorphism.

**UNIT IV Molecular evolution:** Principle – methods of molecular evolution – nucleotide substitution (types and rates). Interpretation of variation in DNA sequence. Molecular clock. Origin of new gene functions – evolution of novel genes and proteins. Molecular phylogeny – phylogenetic tree – reconstruction of phylogenetic relationship – Distance Matrix approach and Parsimony based approach - kinds of molecular phylogenies – Universal Tree of Life. Phylogenetic and biological concept of species. Adaptive radiation. Isolating mechanisms. Modes of speciation (allopatry and sympatry).

**UNIT V Origin of higher categories:** Major trends in the origin of higher categories. Microevolution, macroevolution, megaevolution and co-evolution. Evolution rates, phyletic gradualism and punctuated equilibrium. Origin and Evolution of Primates: Evolution of Anthropoid Primates - The first hominids and origin of modern man - Bipedalism – communication – speech – language - altruism and morality. Evolution of culture.

#### **Reference Books**

1. Peter Snustad, D. & Michael J. Simmons (2009). Principles of Genetics (5<sup>th</sup> ed.). USA: John Wiley & Sons, Inc.
2. Eldon John Gardner, Michael J. Simmons & D. Peter Snustad (2005). Principles of Genetics (8<sup>th</sup> ed.). New Delhi: Wiley (India) Pvt. Ltd.
3. Monroe W. Strickberger (2015). Genetics (3<sup>rd</sup> ed.). India: Pearson Education.
4. Robert F. Weaver and Philip W. Hedrick (1989). Genetics. New York: W. M. C. Brown Publishers.
5. Emmanuel. C., Rev. Fr. Ignacimuthu, S. & Vincent, S. (2006). Applied Genetics. Chennai: MJP Publishers.
6. Hickey, G. I., Fletcher, H. L. & Winter, P. (2010). Genetics. New York: Taylor and Francis Group Publications.
7. Sanjib Chattopadhyay (2008). Evolution, Adaptation and Ethology. Kolkatta: Books and Allied Pvt. Ltd.
8. Maynard Smith, J. (1999). Evolutionary Genetics. England: Oxford University Press.
9. Monroe W. Strickberger (2000). Evolution (3<sup>rd</sup> ed.). Sudbery, Massachusetts: Jones and Bartlett Publishers.
10. Mark Ridley (1996). Evolution. England: Blackwell Science Ltd.
11. Arora, M. P. (2000). Organic Evolution. Mumbai: Himalaya Publish House.
12. Tomar, B.S. & Singh, S.P. (2000). Evolutionary Biology. Meerut: Rastogi Publications.
13. Ahuja, N. (2008). Evolution and Population Genetics. New Delhi: Pearl Books.
14. Savage, J.M. (1969). Evolution. New Delhi: Amerind Publishing Co. Pvt. Ltd.

**Semester II**  
**Core VI - Research Methodology**  
**Course Code: PZ1723**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objective**

s

1. To enable the students to understand the working principles of bioinstruments and methodologies used in biological investigations and report writing.
2. To create self employment opportunities using the knowledge acquired.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	demonstrate a broad range of research methodologies and their relevance to specific research problems.	PSO - 1	U
CO - 2	operate instruments like microscope, centrifuge, ph meter and spectrometer and perform experiments on histology, chromatography and electrophoretic techniques.	PSO - 2	Ap
CO - 3	use scientific methods to develop hypotheses, design and execute experiments by selecting the appropriate research techniques.	PSO - 4	Ap; An
CO - 4	conceptualize research processes, data presentation, report writing and publication in journals.	PSO - 5	Ap

**UNIT I Microscope:** Principle – Instrumentation, Types– bright field, dark field, phase contrast, interference, fluorescence, polarization, confocal, electron microscopes – scanning tunneling microscope, atomic force microscope, near field scanning optical microscope, magnetic force microscope. Photography – light – film – camera types – photomicrography.

**UNIT II Centrifugation:** Principle - Factors affecting sedimentation rate – Types and applications of centrifuges. pH meter: principle – electrodes – applications. Cryotechniques – cryopreservation. Cytotechnique: Whole mounts. Microtome: Rotary and Freezing microtome. Microtomy: Fixation – Dehydration – Clearing - Embedding - Sectioning – staining – mounting.

**UNIT III Chromatography:** Principle, types – paper, thin layer, column, gas and liquid chromatography – High Performance Liquid Chromatography – Ion exchange – Affinity chromatography. Electrophoresis: Principles, types – Paper and gel – Polyacrylamide gel, agarose gel, Iso electric focusing – Immunoelectrophoresis. Protein sequencing methods.

**UNIT IV Spectrophotometer:** principle, design and applications. Spectroscopy: principle- design- types- Atomic Absorption Spectroscopy, flame photometer, chemiluminometer, Nuclear Magnetic Resonance spectroscopy, FTIR spectrometry - Electron Spin Resonance, Magnetic Resonance Imaging – applications. Radio activity counters.

**UNIT V Experimental design and Report writing:** Essential steps in research – Literature collection – Review of literature – Research and discriminative reading – Bibliography- Index card – Literature citation – Plagiarism - Alphabet number system – Research report - Tables –



**Reference Books**

1. Veerakumari, L. (2006). Bioinstrumentation. Chennai: MJP Publishers.
2. Gurumani. N. (2006). Research Methodology for Biological Sciences. Chennai: MJP Publishers.
3. Robert L. Dryer & Gene F. Lata (1989). Experimental Biochemistry. New York: Oxford University Press.
4. Rana, S.V.S. (2002). Biotechniques. Meerut: Rastogi Publications.
5. Keith Wilson & John Walker (2000). Principles and Techniques of Practical Biochemistry (5<sup>th</sup> ed.). United Kingdom: Cambridge University Press.
6. Marimuthu, R. (2008). Microscopy and Microtechnique. Chennai: MJP Publishers.
7. Ramnik Sood (2006). Medical Laboratory Technology. New Delhi: Jaypee Brothers Medical Publishers Pvt. Ltd.



**Semester II**  
**Elective II – (a) Developmental Biology**  
**Course Code: PZ1724**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To enable the students to gain knowledge on the process by which a single cell, the zygote, multiply, differentiate and develop into an adult.
2. To gain employment at fertility centers in hospitals, health centers and cryopreservation units.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	discuss basic concepts and develop knowledge on major developmental processes.	PSO - 1	U
CO - 2	explain the development of different organ and organ systems.	PSO - 6	R
CO - 3	analyse the mechanisms regulating developmental processes.	PSO - 7	U; An
CO - 4	evaluate the different technologies adopted in assisted reproduction.	PSO - 9	An; E
CO - 5	apply the concepts in new areas of developmental biology.	PSO - 8	Ap

**UNIT I** Historical perspectives and theories of embryology. Male reproductive system of a mammal, spermatogenesis, structure and function of sperm, factors influencing spermatogenesis, semen and seminal fluid. Female reproductive system of a mammal, female gonad, Oogenesis, ovulation, Regulation of ovulation. Vitellogenesis, types of eggs.

**UNIT II** Fertilization and molecular aspects: Mechanism of fertilization, theories of fertilization and post fertilization changes. Cleavage: Laws of cleavage, planes – patterns – chemical changes during cleavage. Cleavage and blastulation in chick and mammal. Cell lineage, Fate map of chick and mammal. Gradient theory. Morphogenetic pattern and fields.

**UNIT III** Morphogenetic movements: Gastrulation in chick and mammal. Germinal layers and their derivatives in vertebrates. Neurogenesis, Notogenesis, Development of mesoderm and coelom. **Organogenesis in vertebrates:** Central nervous system, eye, skin and its derivatives, heart, kidney, limbs, alimentary canal and its derivatives.

**UNIT IV** Development of reproductive organs in man: development and differentiation of testis, development of male genital ducts and accessory glands. Development and differentiation of ovary, development of female genital ducts and accessory glands. Infertility – causes and treatment, Assisted Reproductive Technology (ART), Family planning. Development of extra embryonic membranes. Placentation in mammals.

**UNIT V** Embryonic induction in vertebrates – types – exogenous and endogenous. Theories of organizer or inductor, competence. Differentiation - characteristics and types, selective action of genes in differentiation. Teratogenesis and teratogens. Metamorphosis in insects and

amphibians. Neoteny. Regeneration – regenerative ability in animals and mechanism. Asexual reproduction, Parthenogenesis and types.

**Reference books**

1. Balinsky, B. I. (1981). An Introduction to Embryology (5<sup>th</sup> ed.). Philadelphia: Holt-Saunders.
2. Wolpert, L. (2010). Principles of Development (4<sup>th</sup> ed.). United Kingdom: Oxford University Press.
3. Ronald W. Dudek & James D. Fix (2005). Embryology (3<sup>rd</sup> ed.). Philadelphia, USA: Lippincott Williams and Wilkins Publication.
4. Twyman, R. M. (2004). Developmental Biology. New Delhi: BIOS Scientific Publishers.
5. Verma, P. S. & Agarwal, V. K. (2014). Chordate Embryology: Developmental Biology. New Delhi: S. Chand & Company Ltd.
6. Gayatri Prakash (2007). Reproductive Biology. United Kingdom: Alpha Science International Ltd.

**Semester II**  
**Elective II - (b) Bioinformatics**  
**Course Code: PZ1725**

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

- To understand the application of computer technology, to study and process the biological data.
- To develop skills to use bioinformatics tools.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the basics of bioinformatics.	PSO - 1	U
CO - 2	explain bioinformatics tools and data bases.	PSO - 2	R
CO - 3	gain knowledge on sequence alignment and alignment programs.	PSO - 2	U
CO - 4	identify the tools for drug discovery, docking and molecular phylogeny.	PSO - 2	An
CO - 5	use bioinformatics tools for molecular data analysis and submission.	PSO - 3	Ap; An

**UNIT I** Introduction to Bioinformatics. Basics of computer and Information Technology – parts of a computer, memory and operating system, Internet, search engines. Genomics – structural, comparative and functional. Proteomics – expression, structural and functional. Types of sequences used in Bioinformatics – DNA sequences, RNA sequences, Protein sequences. Applications of Bioinformatics.

**UNIT II** **Bioinformatics Databases:** Types of databases. Biological databases: nucleotide sequence databases - GenBank, DDBJ, EMBL, NCBI; Protein sequence databases – SWISS-PROT, Uniprot, TrEMBL; Structure databases – PDB, NDB, PubChem, ChemBank, CSD; Bibliographic databases- MEDLINE, PUBMED. Database programs –DBMS and RDBMS. Data retrieval systems – SRS, ENTREZ and DBGET.

**UNIT III** **Sequence Analysis:** Sequence alignment and alignment programs; Comparison of two sequences – Dot Matrix analysis; Scoring schemes – PAM Matrices and BLOSUM Matrices; Dynamic programming – Needleman-Wunch algorithm, Smith-Waterman algorithm, BLAST and FASTA; Multiple Sequence Alignment, ClustalW; Storing alignments.

**UNIT IV** **Drug Designing:** Drug discovery process – drug target identification, target validation, Lead compound identification, Lead optimization, Docking (importance, mechanics of docking, docking sites), Quantitative structure-activity relationship. Preclinical and clinical development. Medical informatics: Hospital management and information system, computer based patient records, computer assisted surgical techniques, searching and retrieval of medical literature.

**UNIT V** **Phylogenetic analysis:** Molecular phylogenetic analysis; methods of phylogenetic analysis - phenetic and cladistic; phylogenetic trees, methods for determining evolutionary trees – maximum parsimony, distance and maximum likelihood; phylogenetic software

resources. Programming for bioinformatics: IT fundamentals, operating systems, programming concepts, HTML, web technologies, common gateway interface.

#### Reference Books

1. Gladis Helen Hepsyba, S. & Hemalatha, C.R. (2009). *Basic Bioinformatics*. Chennai: MJP Publishers.
2. John De Britto, A. (2011). *Bioinformatics*. Sivakasi; Anto Art Craft Printers.
3. Sundaralingam, R. & Kumaresan, V. (2008). *Bioinformatics*. Nagercoil: Saras Publication.
4. Jin Xiong (2006). *Essential Bioinformatics*. USA: Cambridge University Press.
5. Hooman H. Rashidi & Lukas K. Buehler (2000). *Bioinformatics Basics: Application in Biological Science and Medicine*. New York: CRC Press.
6. Mohan Bansal, A.S. (2003). *Medical informatics – A primer*. New Delhi: Tata McGraw- Hill Publishing Company Ltd.

**Semester II**  
**Practical II (Biostatistics, Computer applications and Bioinformatics, Genetics and Evolution & Research Methodology)**  
**Course code: PZ17P2**

No. of hours/week	No of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To design an experimental problem and valuate critically with inferential biostatistics and necessary computer skills.
2. To understand the mechanism of heredity, evolution and population genetics.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	collect, analyze and interpret data using statistical methods.	PSO - 1	Ap; An
CO - 2	compute data using ms excel and identify data bases using bioinformatic tools.	PSO - 2	Ap; E
CO - 3	compute and calculate gene frequencies for solving genetic issues.	PSO - 2	Ap; E
CO - 4	analyze the evolutionary concepts through experiments.	PSO - 2	An
CO - 5	perform whole mounting of specimen, histotechniques and adopt separation procedures using chromatography.	PSO - 4	Ap

**Biostatistics, Computer applications and Bioinformatics**

1. Collection of data - insect population in the campus.
2. Graphical representation of collected data.
3. Diagrammatic representation of collected of data.
4. Measures of central tendency: mean, median and mode.
5. Measures of dispersion- Standard deviation and standard error.
6. Correlation co-efficient – height - weight relationship, length and width of molluscan shells.
7. Study of probability using coin tossing with 2 and 3 coins and chi square test
8. Regression Analysis.
9. Test of significance (student's t-test).
10. Preparation of graph using M.S. Excel.

**Charts/ Models**

NCBI, SWISS-PROT and PubMed

**Genetics and Evolution**

1. Demonstration of monohybrid and dihybrid cross using beads.
2. Identification of sex and mutant forms of Drosophila.

3. Calculation of gene frequencies using Hardy-Weinberg equilibrium - ABO blood group.

4. Demonstration of natural selection using beads.

5. Demonstration of genetic drift using beads.

6. Analysis of variation in finger print patterns.

7. Study of homologous organs (fore limbs and hind limbs of vertebrates).

8. Study of analogous organs (wings of animals).

9. Adaptive radiation - beaks in Birds.

#### **Specimens / Charts / Models / Photographs**

Karyotype of syndromes, Pedigree chart, Fossils (Ammonite, Trilobite, Nautiloid fossil), Living fossil (Limulus, Peripatus), Connecting link (Archaeopteryx), leaf insect, stick insect.

#### **Research Methodology**

1. Whole mount preparation of five specimens.

2. Separation of amino acids using thin layer chromatography.

3. Sectioning and staining of a tissue.

4. Separation of pigments by column chromatography using plant extract (Demonstration).

5. Gel electrophoresis (Demonstration).

#### **Instruments/ Charts/ Models**

Phase contrast microscope, fluorescent microscope, pH meter, centrifuge, spectrophotometer, flame photometer, microtome, Chromatography column, electrophoretic apparatus, Index card.



**Semester III**  
**Core VII - Physiology**  
**Course Code: PZ1731**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To impart knowledge on the structure and functions of various organs, organ systems and also to know about the associated disorders.
2. To get job in diagnostic centers, research and academic institutions.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	describe the anatomy of different physiological systems at the tissue and cellular levels.	PSO - 1	U
CO - 2	evaluate the physiological functioning of different organs.	PSO - 2	E
CO - 3	analyze the physiological changes in relation to environmental conditions.	PSO - 7	Ap; An
CO - 4	identify different tissues related to anatomy and physiology from an evidence-based perspective.	PSO - 9	U
CO - 5	carry out physiological studies in the laboratory, interpret data and graphs and write a report.	PSO - 9	Ap; An

**UNIT I Nutrition:** types of nutrition and feeding mechanisms in animals. Digestion - Functional anatomy of the digestive system (human), Movements of gastrointestinal tract, Secretory functions of the alimentary tract and glands, Digestion and absorption. Metabolism of protein, carbohydrate and lipid. **Balanced diet – Malnutrition - Energy balance – BMR. Gastrointestinal disorders: Gall stones, liver cirrhosis, gastritis, peptic ulcer and appendicitis.**

**UNIT II Respiration and Homeostasis:** Respiratory organs and respiratory pigment in animals, Physiological anatomy of the respiratory system (human), Transport of respiratory gases, Regulation of respiration, Respiratory problems - bronchial asthma, pneumonia and pulmonary tuberculosis. Homeostasis: Osmoregulation - types and mechanism. Thermoregulation – classification, thermoregulatory mechanism in animals, aestivation and hibernation, **Deep sea physiology, High altitude and space physiology, Effects of exposure to cold and heat. Bioluminescence – physiology and functions.**

**UNIT III Circulation:** Components and functions of blood, Blood clotting. Haemopoiesis. Myogenic and neurogenic heart. Functional anatomy of human heart, Cardiac cycle, pacemaker, heart rate, Bradycardia and tachycardia, Regulation of cardio-vascular system. **Blood pressure, sphygmomanometer, Electrocardiogram (ECG), Heart diseases (Atherosclerosis, coronary**

thrombosis and angina pectoris). Lymphatic system - organization, composition of lymph and functions.

**UNIT IV Neuro-muscular system:** Structure of the brain and neuron, Neurotransmitters, Synapse, Nerve impulse conduction, Reflex activity, Inborn and conditioned reflex actions, Electroencephalogram. Neural disorders - Meningitis and epilepsy. Types of muscle, structure and properties of skeletal muscle, Mechanism of muscle contraction, Neuromuscular junction. Sense organs - Structure and functions of skin, eye and ear.

**UNIT V Excretion and Reproduction:** Excretory organs in different groups of animals, Patterns of excretion, Structure and function of kidney (human), Nephron, Formation of urine, Micturition, Renal disorders – nephritis, renal calculi, Dialysis. Structure of testis and ovary (human), oestrus and menstrual cycle, ovulation, pregnancy, parturition and lactation, hormonal regulation of reproduction.

#### Reference Books

1. Sembulingam, K. and Prema Sembulingam (2013). Essentials of Medical Physiology (6<sup>th</sup> ed.). Bangalore: Jaypee Brothers Medical Publishers Pvt. Ltd.
2. Guyton and Hall (2010). Textbook of Medical Physiology (12<sup>th</sup> ed.). Philadelphia: John E. Hall, Saunders Elsevier.
3. Elaine N. Marieb (2003). Human Anatomy and Physiology (6<sup>th</sup> ed.). San Francisco: Daryl Fox publisher.
4. Sawant, K.C. (2011). Human Physiology. New Delhi: Wisdom Press/ Dominant Publishers and Distributors Pvt Ltd.
5. Sarada Subrahmanyam and Madhavankutty, K. (2001). Text Book of Human Physiology (6<sup>th</sup> ed.). New Delhi: S. Chand and Company Ltd.
6. William. S. Hoar (1984). General and Comparative Animal Physiology (2<sup>th</sup> ed.). Prentice Hall of India.
7. Prosser, C. L. (1991). Comparative Animal Physiology (4<sup>th</sup> ed.). United States: John Wiley and Sons Ltd.
8. Nielsen Knut Schmid (2007). Animal Physiology, Adaptation and Environment (5<sup>th</sup> ed.). New Delhi: Cambridge University Press.
9. Nagabushnam, R., Kadarkar, M.S. and Sarojini, R. (2002). Textbook of Animal Physiology. New Delhi: Oxford and IBH Publishing Company.
10. Sobti, R.C. (2008). Animal Physiology. New Delhi: Narosa Publishing House Pvt. Ltd.
11. Rastogi, S.C. (2007). Essentials of Animal Physiology (6<sup>th</sup> ed.). New Delhi: JBA Publishers.

**Semester III**  
**Core VIII - Immunology**  
**Course Code: PZ1732**

No. of hours/ week	No. of credits	Total number of hours	Marks	Objectives
6	4	90	100	

1. To facilitate the students to understand and appreciate the defense functions of the immune system.
2. To develop the skill to determine the immunomodulatory strategies used to enhance or suppress the immune response.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the importance of innate immune response in providing adaptive immunity.	PSO - 1	U
CO - 2	know the evolution of immune molecules in different groups of animals.	PSO - 1	U
CO - 3	differentiate the types of hypersensitive allergic reactions by seeing the symptoms and duration and suggest the remedies.	PSO - 2	R; An
CO - 4	discuss the role of immune molecules in different diseases and organ transplantation.	PSO - 6	Ap
CO - 5	demonstrate detailed knowledge and understanding of immunology and the way it is applied in diagnostic and therapeutic techniques and research.	PSO - 9	U; Ap

**UNIT I Immune system in invertebrates and vertebrates:** Immunity - Innate and acquired, II, III and IV line of defense. Types – natural and artificial - active and passive immunity; Lymphoid organs and cells involved in immune response. Antigens and Immunoglobulins – characteristics, haptens, types. Immune Response: Humoral and Cell mediated immune response - primary and secondary immune response, importance of B cells in humoral immune response (antibody formation), factors influencing antibody formation. Immunological memory (Anamnesis). Immunization: immunization schedule and vaccines.

**UNIT II Major and minor histocompatibility complex:** MHC class I and II molecules, cellular distribution and regulation of MHC expression, MHC in immune responsiveness, MHC and susceptibility to infectious diseases. Minor histocompatibility (H) antigens. Immune effector mechanisms: Cytokines and their functions, Complement system – classical and alternate pathways, biological functions.

**UNIT III B and T cell:** B cells - Maturation, activation and differentiation - B cell receptor (BCR) - B cell co-receptor complex - signal transduction from B cell antigen receptor, major pathways of BCR signaling. T cells - maturation, activation and differentiation, T cell receptor (TCR), T cell co-receptor complex - formation of T and B cell conjugates, Co-stimulation in T

cell response and signal transduction. Clonal anergy. Antigen processing and presentation – role of antigen presenting cells – cytosolic pathway and endocytic pathway.

**UNIT IV Immune system in health and diseases:** Tumour immunology - properties of tumour cells, causes of tumours, tumour antigens, immune response to tumour, immune surveillance, immunodiagnosis of tumour antigens, immuno therapy of tumour. Hypersensitivity: factors causing hypersensitivity, Type I, II, III, and IV reactions. Immunodeficiency - primary and secondary. Autoimmune diseases - characteristics, causes, classification, localized (Diabetes mellitus, Addison's disease) and systemic (systemic lupus erythematosus, rheumatoid arthritis). Immune response to infectious diseases and treatment - Protozoan disease (Malaria), Bacterial disease (Tuberculosis), Viral disease (AIDS).

**UNIT V Antigen-antibody interaction:** strength, affinity, avidity and cross reactivity. Complement fixation test - precipitation reaction in fluids and precipitin curve. Radial immunodiffusion and double immunodiffusion. Immunoelectrophoresis – counter and rocket electrophoresis. Agglutination reaction - hemagglutination, bacterial agglutination, coated particle agglutination, agglutination inhibition. Radio immuno assay - ELISA – Western blotting - Immunofluorescence - Flow cytometry. Transplantation: classification of grafts, mechanism of graft rejection, graft versus host reaction, immuno suppressive therapy during transplantation.

#### Reference Books

1. Goldsby, R.A., Kindt, T.J. and Osborne, B.A. (2007). Kuby's Immunology (6<sup>th</sup> ed.). New York: W.H. Freeman and Company.
2. Delves, P., Martin, S., Burton, D., Roitt I.M. (2006). Roitt's Essential Immunology (11<sup>th</sup> ed.). Oxford: Wiley-Blackwell Scientific Publication.
3. Ashim, K., Chakravarthy (2007). Immunology and Immunotechnology (2<sup>th</sup> ed.). Delhi: Saurabh Printers Pvt. Ltd.
4. Dasgupta, A. (1992). Modern Immunology (2<sup>th</sup> ed.). New Delhi: Jaypee Brothers Medical Publications Pvt. Ltd.
5. Gupta, S.K. (1991). Immunology perspectives in Reproduction and Infection. New Delhi: Oxford and IBH publication Co. Pvt. Ltd.
6. Hannigan, B.M., Moore, C.B.T. and Quinn, D.G. (2010). Immunology (2<sup>th</sup> ed.). India: Viva Book Pvt. Ltd.
7. Rao, C.V. (2006). Immunology (2<sup>th</sup> ed.). Chennai: Narosa Publishing House.
8. Murphy, K., Travers, P. and Walport, M. Garland (2008). Janeway's Immunobiology (7<sup>th</sup> ed.). New York: Science Publishers.

**Semester III**  
**Elective III – (a) General Endocrinology**  
**Course Code: PZ1733**

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To learn how the endocrine system functions under normal circumstances, as well as the pathologies that arise when homeostasis fails.
2. To get job in clinical laboratory and endocrine research institutes.

**Course Outcomes**

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	discuss the principles of endocrine system, hormonal communication and neuroendocrine mechanism in animals.	PSO - 1	U
CO - 2	explain the secretion and transportation of hormones to maintain homeostasis.	PSO - 10	U
CO - 3	apply the knowledge of endocrinology to understand hormone-related disorders.	PSO - 8	Ap
CO - 4	explain women related physiological processes such as menstruation, gestation and lactation	PSO - 3	Ap
CO - 5	correlate endocrine regulation of reproduction and metamorphosis in various invertebrates and vertebrates.	PSO - 5	Ap; An

**UNIT I Introduction:** Historical perspective and scope of endocrinology. Endocrine methodologies - assay of hormones, surgical methods, radioisotope studies, pharmacological methods, and replacement therapy and animal models for research. Chemical messengers - neurocrine, paracrine, autocrine, endocrine, pheromones and chalone.

**UNIT II Neurosecretion and Neuroendocrine mechanisms:** Neuroendocrine integration-evolution of regulatory mechanisms and endocrine control of neural function. Neuroendocrine mechanisms and functions in insects, crustaceans and non-arthropod invertebrates. Analogous neurosecretory systems of invertebrates and vertebrates.

**UNIT III Endocrine glands and hormones:** Organization of the endocrine system - classification of hormones - structure, functions and patho-physiology of hypothalamus, pituitary, thyroid, parathyroid, adrenal, pancreas, gonads. Gastro-intestinal hormones.

**UNIT IV Hormone synthesis and mechanism of Hormone action:** Biosynthesis, storage and release of amine (catecholamines and thyroxine), protein (growth hormone and insulin) and steroid hormones (sex hormones). Mechanism of hormone action - receptors (membrane and cytosolic) - second messengers, signal transduction, termination of hormone activity. Pathophysiological correlates of hormone action. Endocrine disorders due to receptor number and function. Hormonal therapy.

**UNIT V Endocrine Integration:** Diffuse effect of hormones - Hormonal regulation of growth, development and metabolism, reproductive cycle and pregnancy, parturition and lactation, migration (birds and fishes), behavior and hibernation, neoplastic growth, colour change in vertebrates.

**Reference Books**

1. Mac E. Hadley and Jonathan Levine (2009). Endocrinology. India: Pearson Education (Singapore) Pvt. Ltd.
2. Aubrey Gorbman and Howard A. Bern (1974). A textbook of Comparative Endocrinology. Bombay: John Wiley and Sons, Inc. Wiley Eastern Pvt. Ltd.
3. Barrington, E.J.W (1975). An Introduction to General and Comparative Endocrinology, 5<sup>th</sup> Ed. London: Oxford University Press.
4. Donnell Turner, C. and Joseph T. Bagnara, W.B. (1976). General Endocrinology (6<sup>th</sup> ed.). Philadelphia: Saunders Company.
5. James Griffin and Sergio R. Ojeda (1988). Textbook of Endocrine Physiology. London: Oxford University Press.
6. Prakash S. Lohar (2005). Endocrinology: Hormones and Human Health. Chennai: MJP Publishers.

**Semester III**  
**Elective III – (b) Health Care**  
**Course Code: PZ1734**

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To make the students realize the importance of the health of the body, develop a healthy personality so as to live a healthy and successful life.
2. To acquire independent employable skills in voluntary organizations or in health sectors.

**Course Outcomes**

CO	Upon completion of this course the students will be able to :	PSO addressed	CL
CO - 1	realize quality life and factors that determine health.	PSO - 5	U
CO - 2	identify personal health problems and its remedies.	PSO - 8	R
CO - 3	gain knowledge on motherhood and childcare.	PSO - 8	U; Ap
CO - 4	describe mental and environmental health hazards.	PSO - 5	Ap
CO - 5	discuss alternative medicines and apply safety and first aid measures.	PSO - 5	An; Ap

**UNIT I Concept of health and well-being:** Definition – Physical, mental, social and positive health – Quality of life. Determinants of health: Heredity – Environment – Lifestyle – Socio-economic conditions – Health services. Nutrition and Health: Nutrients that provide energy – Carbohydrates – Lipids – Proteins. Nutrients that regulate: Vitamins – Minerals – Water. Healthy diet – Food guide Pyramid – Snacking – Vegetarian diet – Fast food.

**UNIT II Personal Health Care:** Protecting skin – common skin problems – Dry Skin, Acne, Dermatitis, Psoriasis, skin infections – skin cancer - caring for the skin. Hair – General care, cleaning tips, preventing hair loss, Anti dandruff strategies. Teeth – Common dental problems – General care of teeth – Dental check up. Eye – Common eye problems – Eye diseases – General care of eyes – Vision check up. Ear – general care – do's and don'ts.

**UNIT III Maternal and Child Health:** Motherhood – pregnancy confirmation test – Prenatal care – Intra natal care – problems during pregnancy – Miscarriage and stillbirth – premature birth – labor and delivery - Family planning. Child health: Care of the newborn – Feeding – Nutritional guidelines - Care of the under-five (Toddler and Preschool).

**UNIT IV Environmental and Mental Health:** Mental health: Characteristics – Types: Schizophrenia – Manic depressive psychoses – Paranoia – Neurosis – Personality and character disorders. Environmental health: health in the home environment – pollution at home – diseases. Safety at home: Fall – Fires – Poisoning – Electrical hazards - Safety in road (Auto mobile – Pedestrian) - Disaster management (Severe weather condition – Flood- Lightning – Cyclone – Earthquake - Landslides- Tsunami).

**UNIT V Alternative medicine and First aid: Naturopathy – Homeopathy- Ayurveda – Unani – Siddha. First aid: First aid procedures for dehydration – heart attack – fractures and dislocation, burns – bleeding – poisoning – electric shocks – drowning.**

**Reference Books**

1. Park, K. (1995). Park's Textbook of preventive and social medicine. Jabalpur: M/S Banarsidas Bhanot Publishers.
2. Getchell, Pippin and Varnes (2006). Perspectives on Health. USA: D C Heath & Co.
3. Lakshmana Sarma and Swami Nathan. S. (1960). Speaking of nature cure – Regain, retain and improve health the drugless way. New Delhi: Sterling Publications Pvt. Ltd.
4. Tom Sanders and Peter (2004). Emery Molecular basis of human nutrition. London: Taylor and Francis Publishers.



**Semester III**  
**Practical III (Physiology and Immunology)**  
**Course Code: PZ17P3**

No. of hours/week	No of credits	Total number of hours	Marks
4	4	60	100

**Objectives**

1. To design experiments and apply it in physiological research.
2. To understand the various immune-techniques and apply in immunological experiments.

**Course Outcomes**

CO	Upon completion of this course the students will be able to	PSO addressed	CL
CO - 1	gain knowledge on the functioning of organ and organ systems.	PSO - 1	U
CO - 2	demonstrate the effect of abiotic factors on the physiology of the systems through experiments.	PSO - 2	Ap; An
CO - 3	identify the immune cells in a blood smear.	PSO - 1	R
CO - 4	demonstrate immune-techniques on antigen-antibody interaction.	PSO - 10	Ap

**Physiology**

1. Effect of temperature on heartbeat of Freshwater Mussel and calculation of  $Q_{10}$ .
2. Effect of temperature on salivary amylase activity and calculation of  $Q_{10}$ .
3. Effect of pH on salivary amylase activity.
4. Salt loss and salt gain in a freshwater fish.
5. Examination of excretory products of fish, bird and mammals.
6. Survey of digestive enzymes in Cockroach.
7. Counting of blood cells using haemocytometer.
8. Haemolysis of blood – Demonstration.
9. Observation of haemin crystals in blood.
10. Estimation of haemoglobin (any method).

**Charts/ Slides/ Models/ Bookplates/ Instruments:** EEG, ECG, Conditional reflex, Skeletal muscle, Kymograph, Sphygmomanometer, Intestine, Nervous tissue, Liver, Lungs, Heart, Kidney.

**Immunology**

1. Dissection of Lymphoid organs of a vertebrate (Demonstration).
2. Histology of lymphoid organs (Chart / CD).
3. Identification of various types of immune cells in peripheral blood smear.
4. Separation and preparation of cellular antigen (RBC and bacteria).
5. Methods of immunization- Intravenous, intraperitoneal and subcutaneous routes.
6. Methods of blood collection and serum preparation.
7. Antigen antibody interaction: Blood typing and Haemagglutination.

8. ELISA test (Demonstration).

9. Radial immunodiffusion.

10. Double immunodiffusion.

**Spotters**

Immunoelectrophoretic apparatus, Semi dry blotting apparatus, Counter current immunoelectrophoresis (chart), Rocket immunoelectrophoresis (chart).

**Semester III**  
**PG - Self-Learning Course**  
**Life Science for Competitive Examinations – I**  
**Course Code: PZ17S1**

No of credits	Marks
2	100

**Objectives**

1. To enable the students to gather information on various topics in biology.
2. To face competitive examinations like UGC – CSIR, NET and other similar examinations.

**UNIT I**

**Molecules and their interaction relevant to Biology:**

- A. Structure of atoms, molecules and chemical bonds.
- B. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins).
- C. Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
- D. Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
- E. Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers.
- F. Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes.
- G. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).
- H. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).
- I. Stability of proteins and nucleic acids.
- J. Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

**UNIT II**

**Cellular Organization:**

- A. Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).
- B. Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).
- C. Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).
- D. Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

E. Microbial Physiology (Growth yield and characteristics, strategies of cell division, stress response)

**Fundamental Processes:**

A. DNA replication, repair and recombination (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination).

B. RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).

C. Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins).

D. Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

**UNIT III**

**Cell Communication and Cell Signaling:**

A. Host parasite interaction Recognition and entry processes of different pathogens like bacteria, viruses into animal and plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells.

B. Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

C. Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

**D. Cancer**

E. Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

F. Innate and adaptive immune system Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell-mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines.

**UNIT IV**

## **Developmental Biology:**

- A. Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development
- B. Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.
- C. Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in Dictyostelium; axes and pattern formation in Drosophila, amphibia and chick; organogenesis – vulva formation in Caenorhabditis elegans, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.
- D. Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum.
- E. Programmed cell death, aging and senescence.

## **UNIT V**

### **System Physiology – Plant:**

- A. Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub> and CAM pathways.
- B. Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.
- C. Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.
- D. Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.
- E. Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.
- F. Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates.
- G. Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.
- H. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

### **System Physiology – Animal:**

- A. Blood and circulation - Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis.
- B. 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.

- C. Respiratory system - Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration.
- D. Nervous system - Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture.
- E. Sense organs - Vision, hearing and tactile response.
- F. 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.
- G. Thermoregulation - Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization.
- H. Stress and adaptation
- I. Digestive system - Digestion, absorption, energy balance, BMR.
- J. Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes, gametogenesis, ovulation, neuroendocrine regulation

#### **Reference Books**

1. Vijay N. Waghmare (2004). Life sciences for NET/SLET exams of UGC-CSIR. Maharashtra: Mudra Publication.
2. Dr. A P Singh & Kumar Pushkar (2010). CSIR-UGC NET/JRF/SLET Life Sciences (Paper I & II). New Delhi: Upkar Publishers.
3. Arun Chaudhary, B. L., Chaudhary and Kailash Choudhary (2007). CSIR/NET Life Sciences. New Delhi: New Age Publishers.
4. Kumar Pranav Mina Usha (2011). CSIR-JRF-NET: Life Sciences Fundamentals and Practice (Part - I). New Delhi: Pathfinder Academy.
5. Ashish Nagesh, Quaisher J. Hossain, Prashant Kumar (2012). UGC-CSIR NET (JRF & LS) Life Science. Chennai: Arihant Publishers.
6. Rupendra Singh (2014). CSIR NET/JRF Life Sciences (4<sup>th</sup> ed.). Lucknow: Catalyst Center of Excellence Pvt. Ltd.
7. Pramod Singh (2014). Trueman's UGC CSIR-NET Life Sciences. New Delhi: Danika Publishing Company.
8. RPH (2014). CSIR-UGC NET Life Science (Popular Master Guide): Life Sciences, RPH Editorial Board.
9. Pranav Kumar (2013). MCQs Life Sciences – Biotechnology (3<sup>rd</sup> ed.). New Delhi: Pathfinder Academy.

**Semester IV**  
**Core IX - Microbiology**  
**Course Code: PZ1741**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

**Objectives**

1. To know about the microbes in and around us and recognize their role in industrial production of valuable products, environmental management, biomining and also about the diseases caused by them.
2. To provide careers in industries, clinical laboratories, agricultural establishments, research institutes and Universities.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the structure, distribution, classification and life cycle of microorganisms.	PSO - 1	U
CO - 2	culture microbes by selecting appropriate culture media.	PSO - 2	R; Ap
CO - 3	explain the role of microbes in food industries and environmental cleaning.	PSO - 7	R
CO - 4	identify the microbial pathogen and preventive measures.	PSO - 9	Ap
CO - 5	develop microbiological laboratory skills applicable to clinical research.	PSO - 10	Ap

**UNIT I Introduction:** History and scope, classification of microorganisms, Whittaker's five kingdom classification, three domain classification. Virus - General properties, structure of viruses, viral taxonomy, bacteriophages, reproduction of DNA and RNA phages, temperate bacteriophages and lysogeny, cytocidal infections and cell damage, persistent, latent and slow virus infections. Cultivation of viruses and purification assays. Viruses and cancer. Viroids and prions.

**UNIT II Bacteria:** Classification, Bergey's system of bacterial classification, Bacterial morphology and fine structure of Escherichia coli. Bacterial nutrition - Common nutrient requirements, Nutritional classes, Uptake of nutrients. Bacterial growth and measurement of growth - Influence of environmental factors on growth, Synchronous growth, Continuous culture, Chemostat and turbidostat. Types of culture media - Pure culture and methods of isolating pure cultures (streak plate technique and pour-plate technique).

**UNIT III Industrial Microbiology:** Fermentation and microbes - fermenter and types of fermenters (air-lift fermenter and stirred tank fermenter). Production of microbial products - alcohol (ethanol), antibiotics (penicillin), vitamin B<sub>2</sub> and Vitamin B<sub>12</sub>. Biofertilizers - steps for preparing bacterial biofertilizers, mass cultivation of Cyanobacteria and Azolla, production of

mycorrhizal fungi and VAM fungi. Bacterial insecticides – Pseudomonas species and Bacillus species. Food spoilage and food preservation.

**UNIT IV Environmental Microbiology:** Drinking water and microbiological analysis of water purity - Coliform test, Most Probable Number (MPN) test, and Membrane Filter (MF) test. Purification of water. Sewage treatment – small scale, large scale (primary, secondary and tertiary) treatment. Biogas production – solubilization, acetogenesis and methanogenesis. Microbial leaching – copper and uranium leaching. Biodegradation of petroleum and xenobiotics.

**UNIT V Antimicrobial agents:** classification, Drug administration, determination of antimicrobial activity, mechanism of antimicrobial agents, effectiveness of antimicrobial drugs, drug resistance, drug dosage, antibacterial drug (penicillin), antifungal drug (nystatin), antiviral drug (amantadine). Current problems of antibiotic resistance in man. Microbes and diseases - Gnotobiotic animals, distribution of normal micro biota of the human body, Mechanism of microbial pathogenesis, Nosocomial infections. Protozoan diseases - Malaria and Amoebiasis. Fungal diseases - Mycotoxicosis and Aspergillosis. Bacterial diseases - Air borne diseases – Meningitis and Streptococcal pneumonia. Food and water borne diseases - Cholera and Typhoid. Soil borne diseases - Tetanus and Anthrax. Sexually transmitted and contact diseases – Gonorrhoea and Syphilis. Viral diseases - Ebola, Hepatitis-B, Rabies and AIDS.

#### Reference Books

1. Dubey R.C. and Maheswari, D.K. (2010). A textbook of Microbiology (3<sup>rd</sup> ed.). 3<sup>rd</sup> Ed. New Delhi: S. Chand and Co.
2. John L. Ingraham and Catherine A. (2004). Introduction to Microbiology. UK: Inghram Thomson Books / Cole.
3. Pelzar, Chan and Krieg (2006). Microbiology. New Delhi: Tata McGraw Hill Publishing Company Ltd.
4. Joanne Willey, Linda Sherwood, Chris Woolverton (2013). Prescott's Microbiology (9<sup>th</sup> ed.). New York: WCB McGraw Hill Co.
5. Vijaya Ramesh, K. (2004). Environmental Microbiology. Chennai: MJP Publishers.
6. Powar, C.B. and Dagainawala, H.F. (2008). General Microbiology, Vol. 2. Chennai: Himalaya Publishing House.
7. Singh, R.P. (2007). General Microbiology. New Delhi: Kalyani Publishers.



**Semester IV**  
**Core X - Ecobiology**  
**Course Code: PZ1742**

No. of hours/ week	No. of credits	Total number of hours	Marks
6	4	90	100

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es**

1. To provide the opportunity for students to develop a deep understanding of various aspects of the environment and apply that knowledge to current environmental issues and for wise environmental management.
2. To work productively with those within and beyond the academy on interdisciplinary collaborative projects.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the interaction of organisms with the physical and biological environment.	PSO - 1	U
CO - 2	compare the differences in the structure and function of different types of ecosystems.	PSO - 1	U
CO - 3	assess the human population increase with respect to anthropological activities and environmental impact.	PSO - 2	E; An
CO - 4	formulate hypotheses and test them by designing appropriate experiments, analyze, interpret data and report	PSO - 3	C; An; E
CO - 5	use scientific knowledge of ecology to evaluate contemporary social and environmental issues.	PSO - 5	Ap; E
CO - 6	participate in environmental protection and conservation.	PSO - 3	Ap

**UNIT I Introduction:** Scope of Ecobiology and need for public awareness. **Ecosystem:** Concepts of ecosystem – structure and functions. Energy flows – single channel energy model, Y - shaped energy flow models. Productivity - Primary production, secondary production, measurement of primary productivity. **Habitat ecology:** freshwater, marine, estuarine, mangrove and terrestrial.

**UNIT II Population:** Structure and regulation, growth form, population fluctuations, population processes. Life table - diagrammatic and conventional life tables, Life history strategies. **Community:** Concept, basic terms, community structure, composition and stratification. Ecological niche, Ecotone and Edge effect, Ecotype. **Ecological succession:** types, general process, Concept of climax.

**UNIT III Environment in action:** Climatic factors (climate, precipitation, temperature, light, oxygen, carbon dioxide and pH), topographic factors, edaphic factors (soil formation, soil profile, soil organisms), biotic factors (symbiosis, commensalism, parasitism and competition). **Biological clock:** biological rhythms and mechanism of biological clock. **Natural resource ecology:** Concept and classification of resource, mineral resource, land resource, forest resource, water resource, energy resource (conventional and non-conventional).

**UNIT IV Biogeochemical cycles:** water cycle, carbon cycle, nitrogen cycle, sulphur cycle and phosphorous cycle. **Biogeography:** patterns of distribution (continuous, discontinuous, endemic), descriptive zoogeography, zoogeographical regions of the world. Dynamic biogeography (dispersal dynamics, dispersal pathways, migration, ecesis). **Natural Disasters:** Floods, earthquakes, cyclones, landslides, Tsunami, Mitigation and Disaster Management. **Urbanization:** Possible advantages of urbanization – problems, solutions. Remote sensing and its applications.

**UNIT V Pollution ecology:** Causes, effects and control measures of air pollution, water pollution, soil pollution, noise pollution, thermal pollution, nuclear hazards. Green House Gas emission and climate change. **Waste management:** solid, liquid and gaseous wastes. e-wastes. **Toxicology:** Biomagnification and bioaccumulation, toxicants, classification, toxicity ( $LC_{50}$  and  $LD_{50}$ ), mode of action.

#### **Reference Books**

1. Eugene P. Odum, Murray Barrick, Gary W. Barret (2005). Fundamentals of Ecology (5<sup>th</sup> ed.). UK: Brooks/Cole Publishers.
2. Begon and Mortimer (1992). Population Ecology. Delhi: UBS Publishers.
3. Kormondy, Edward, J. (1994). Concept of Ecology. Delhi: Prentice Hall of India Pvt. Ltd.
4. Sharma, P.D. (1999). Ecology and Environment. Meerut: Rastogi Publications.
5. Dash, M.L. (1996). Fundamentals of Ecology. New Delhi: Tata McGraw Hill Publishing Company Ltd.
6. Trivedi, P.C. and Sharma, K.C. (2003). Biodiversity Conservation. Jaipur: Avishekar Publishers.
7. Trivedi, R.N. (1993). Textbook of Environmental Sciences. New Delhi: Anmol Publications Pvt. Ltd.
8. Shukla, S.K. and Srivastava, P.R. (1992). Water Pollution and Toxicology. New Delhi: Common-Wealth Publishers.
9. Subramanian, M.A. (2004). Toxicology: Principles and methods. Chennai: MJP Publishers.
10. Verma, P.S. and Agarwal V. K. (1986). Principles of Ecology. New Delhi: S. Chand & Co. Pvt. Ltd.

**Semester IV**  
**Core XI - Biotechnology and Nanobiology**  
**Course Code: PZ1743**

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	4	90	100

**Objec  
tives**  
1. To

enable the students to understand the essence of biotechnology and become aware of the advances in Nanobiology.

2. To develop skill of technical proficiency in genetic manipulation to try to improve agricultural production, pharmaceutical products, medical treatment, or mitigation of environmental pollution.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the basic concepts of gene cloning and the importance of dna sequencing in biotechnological intervention.	PSO - 1	U
CO - 2	demonstrate cell culture techniques and prepare protocol to perform experiments.	PSO - 2	U; Ap
CO - 3	identify the progression of biotechnology in different areas like medicine, agriculture, environmental sustainability and forensics.	PSO - 2	R
CO - 4	apply the knowledge of genetically modified organism in bioremediation.	PSO - 4	Ap; An; C
CO - 5	outline the basic concepts of nanotechnology, its applications and threat to the environment.	PSO - 9	U
CO - 6	communicate the concepts of biotechnology and develop research skills.	PSO - 4	Ap

**UNIT I Gene cloning:** Basic steps of gene cloning, restriction and modifying enzymes, linkers and adaptors, cloning and expression vectors, construction of chimeric DNA, nucleic acid probes, DNA libraries, polymerase chain reaction, molecular markers, DNA sequencing, synthesis of oligonucleotides. Human Genome Project.

**UNIT II Animal Biotechnology:** Primary culture and cell lines, pluripotent stem cell lines, tissue engineering. In vitro fertilization and embryo transfer in animals; gene transfer methods. Primary explantation techniques – organ and embryo culture – transgenic animals and the knockouts. Biotechnology and aquaculture - ploidy induction, gynogenesis and androgenesis.

**UNIT III Medical Biotechnology:** Hybridoma technology and Monoclonal antibodies – Applications of biotechnology in medicine, Vaccines, diagnostics and forensics. Gene therapy – Pharmacogenomics. **Enzyme biotechnology:** Isolation and purification of enzymes, uses of enzymes in industries, immobilization of enzymes and their uses, Biosensors. Terminator and traitor technology. Intellectual Property Rights.

**UNIT IV Industrial and Environmental Biotechnology:** Production of metabolites - Downstream processing and in situ recovery of products, microbial biotransformation, microbial biomass production (SCP). Bioremediation and phytoremediation - Genetically

engineered microorganisms (GEMs) - treating oil spills, detection of pesticide in soil and their degradation, sequestering heavy metals. Biomining and Biofuels.

**Unit V Nanomaterials:** Types and properties, DNA and protein nanoarrays, biosystems (microbes) as nanofactories. Application of nanotechnology - medical diagnostics, imaging and drug delivery, agro-practices and food related nanoproducts, cosmetics, contact lenses and dental implants. Nanotechnological approaches for environmental remediation, prevention of contamination, environment maintenance and quality enhancement. Risks and threats of nanoparticles in environment.

#### Reference Books

1. Gupta P.K. (2009). Elements of Biotechnology. Meerut: Rastogi Publications.
2. Singh B.D. (2003). Biotechnology - Expanding Horizons. Chennai: Kalyani Publishers.
3. Satyanarayana V. (2004). Biotechnology. Kolkata: Books and Allied (P) Ltd.
4. Dubey R.C. (2006). A Text Book of Biotechnology (4<sup>th</sup> ed.). New Delhi: S. Chand and Co. Ltd.,
5. Rema L.P. (2006). Applied Biotechnology. Chennai: MJP publishers.
6. Prakash S. Lohar, (2012). Biotechnology. Chennai: MJP publishers.
7. Madhuri Sharon, Maheshwar Sharon, Sunil Pandey and Goldie Oza (2012). Bio-Nanotechnology: Concepts and Applications. New Delhi: Ane Books Pvt. Ltd.
8. Vinod Labhasetwar and Diandra. L. Leslie-Pelecky (2007). Biomedical applications of Nanotechnology. New Jersey: Wiley Publications.
9. Jo Anne Shatkins (2008). Nanotechnology: Health and Environmental Risks. New York: CRC Press.
10. Y.S. Raghavan (2010). Nanostructures and Nanomaterials: Synthesis properties and applications. New Delhi: Arise Publishers and distributors.
11. Parthasarathy, B.K. (2007). Nanotechnology in Life Science. New Delhi: Isha Books.
12. Rakesh K. Yadav (2009). Investing in Nanotechnology. New Delhi: Mangalam Publications.

**Semester IV**  
**Elective IV – (a) Parasitology**  
**Course Code: PZ1744**

No. of Hours/ week	No. of Credits	Total Number of Hours	Marks
6	5	90	100

**Objectives**

1. To enable the students to be aware of the cosmopolitan distribution of parasites and vectors and their control measures.
2. To obtain job in clinical laboratories and health departments.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	explain the basic biology and lifecycle of parasites including epidemiology, diagnosis and treatment.	PSO - 1	U
CO - 2	recognize morphological characteristics for identification of parasites and their developmental stages.	PSO - 2	R
CO - 3	identify appropriate techniques and develop basic skills for detection of parasites.	PSO - 3	U; R
CO - 4	critically analyze, interpret and discuss factual information on parasites.	PSO - 2	Ap; An
CO - 5	analyze the medical and public health aspects of human parasitic infections.	PSO - 5	An
CO - 6	seek employment in veterinary hospitals, clinical and research laboratories.	PSO - 3	Ap

**UNIT I Introduction:** Historical perspectives - taxonomy and classification of parasites – origin and evolution of parasitism - host parasite relationship, classification of parasites and hosts– transmission of parasites – Parasitic zoonoses – pathogenesis - clinical manifestations of parasitic diseases.

**UNIT II Protozoan parasites:** Introduction and classification. Intestinal Amoeba - Pathogenic free living amoeba – Intestinal flagellates – Trypanosomiasis, Leishmaniasis, Balantoidiasis, Malaria, Isosporiasis, Toxoplasmosis, Cryptosporidiosis, Pneumocytosis. Protozoans of minor medical importance.

**UNIT III Helminth parasites:** Trichiuriasis, Trichinellosis, Strongyloidosis, Ascariasis, Enterobiosis, Filariasis, hook worm diseases, Dracunculiasis, Onchocerciasis, Loiosis – Larva migrants. Nematodes of lesser medical importance - Diphyllbothriasis, Taeniasis, Echinococcosis, Sparganosis, Schistosomiasis, Fascioliosis, Fasciolopsiasis, Paragonimiasis, Clonorchiasis, Trematodes of minor medical importance.

**UNIT IV Parasitic Insects:** Prevalence, transmission and control of parasitic infections. Parasitic infection in compromised host. Applied Parasitology: Eosinophilia in parasitic infections, Nosocomial parasitic infections. Evasion and parasitic mode of life –

morphological, biochemical and ethological adaptations. Quality assurance and laboratory safety.

**UNIT V Diagnostic methods in parasitology:** Microscopical examination of blood, stool, urine, sputum and biopsy material for parasites – general rules for microscopical examination, Cultural examination - preparation of media – techniques for cultivation of *E. histolytica*, *Leishmania*, *Plasmodium*. Immunodiagnostic methods – ELISA, AGD, IHA, IFAT, CFT, DAT, IB, WB, BF, DFAT. Molecular characterization of stage specific antigen nucleotide probes for diagnosis of protozoan diseases.

#### **Reference Books**

1. Cheng, C.T. (1964). *The Biology of Animal Parasites*. Tokyo: Toppan Company Ltd.
2. Chatterjee, K.D. (1981). *Parasitology*. Calcutta: Chatterjee Medical Publishers.
3. Rajesh Karyakarte and Ajit Damle (2008). *Medical Parasitology* (2<sup>nd</sup> ed.). Kolkata: Books and Allied (P) Ltd.
4. Ichhpujani R.L. and Rajesh Bhatia (2002). *Medical Parasitology*. New Delhi: Jaypee printers.
5. Patvaik, B.D. (2001). *Parasitic Insects*. Delhi: Dominant Publishers and Distributors.
6. Jones, A.W. (1976). *Introduction to Parasitology*. Boston, USA: Addison-Wesley Publishing Company.
7. Subah, C.P. (2001). *Textbook of Medical Parasitology*. Chennai: All India publishers and Distributors.

**Semester IV**  
**Elective IV – (b) Medical Entomology**  
**Course Code: PZ1745**

No. of hours/week	No. of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To identify medically important arthropods by their general morphology and important characteristics, to describe their biology, ecology and geographical distribution, their roles in transmission of diseases and nuisance to public health and to describe and apply control methods for arthropod vectors.
2. To propose effective control measures to eradicate vector borne diseases and seek employment opportunities in health centers.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	identify the medically important arthropods by their general morphology and important characteristics.	PSO - 1	R ; U
CO - 2	describe the biology, ecology and geographical distribution of medically important pests and their role in transmission of diseases.	PSO - 2	U
CO - 3	outline the biology of tropical parasites and vectors and the relationship between parasites and their hosts.	PSO - 2	Ap
CO - 4	assess the immunological approaches in the control of parasitic infections.	PSO- 2	E
CO - 5	enumerate strategies for prevention and care of vector borne disease.	PSO - 1	Ap; E

**UNIT I Introduction:** Fundamentals and scope of medical entomology - insects of medical importance: filth breeding insects, venomous insects, parasites of vertebrates, blood sucking insects, insects affecting physiology.

**UNIT II Life cycle of human parasitic insects:** Lice, fleas, mosquitoes, house flies and tsetse fly. Immunity to human parasites - host-parasitic relationships - ecological adaptive features among human parasitic insects.

**UNIT III Vector entomology:** Scope - vector borne diseases - mechanism of transmission in human beings - mechanical, biological and myiasis - common vector insects and their identification: mosquitoes, sand flies, black flies, house fly, tsetse fly, human flea and human louse. Hard and soft tick, trombiculid mite, itch mite and Cyclops.

**UNIT IV Medical importance and management:** Lice - body, head and pubic louse; fleas - flea nuisance, plague, flea-borne endemic typhus; mosquitoes - nuisance, malaria, filariasis, yellow fever, dengue; house flies - common and greater house fly - typhoid, dysentery, diarrhea, cholera, amoebiasis, gastroenteritis; tsetse fly - Gambian and Rhodesian sleeping sickness.

**UNIT V Vector control: Insecticides - use and consequences. Use of bio-control agents and bio-pesticides - bacillus and predatory fishes. National programmes related to vector borne diseases - malaria - N.M.E.P., N.M.C.P – filarial - N.F.C.P. - N.F.E.P.**

**Reference Books**

1. Bruce F. Eldridge and John D. Edman (2004). Medical Entomology - A textbook of public health and veterinary probes caused by Arthropods. Netherlands: Kluwer Academic Publishers.
2. Lance A. Durden (2002). Medical and Veterinary Entomology (3<sup>rd</sup> ed.). Cambridge: Academic Press.
3. Service, M.W. (2004). Medical Entomology for Students (3<sup>rd</sup> ed.). United Kingdom: Cambridge University Press.
4. Walter Scott Patton and Francis William Cragg (2008). A textbook of Medical Entomology. Montana, USA: Kessinger Publishing Pvt. Ltd.



**emester IV**  
**Practical IV (Microbiology, Ecobiology & Biotechnology and Nanobiology)**  
**Course Code: PZ17P4**

No. of hours/week	No of credits	Total number of hours	Marks
6	5	90	100

**Objectives**

1. To acquire and demonstrate competency in laboratory safety and in routine microbiological and biotechnological techniques.
2. To recognize and apply methodological approaches of Ecobiology.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	PSO addressed	CL
CO - 1	isolate, culture, stain and identify bacteria and perform antibiotic sensitivity test.	PSO - 1	Ap
CO - 2	estimate the physico-chemical parameters of water samples.	PSO - 2	An; E
CO - 3	identify the producers and consumers of a pond ecosystem and measure the primary productivity.	PSO - 1	R; Ap
CO - 4	extract and quantify genomic dna.	PSO - 1	Ap
CO - 5	prepare commercial products by using biotechnological methods.	PSO - 9	C

**Microbiology**

1. Sterilization of glassware.
2. Preparation of culture media.
3. Isolation of bacteria from soil, air and water.
4. Serial dilution – pure culture of soil bacteria.
5. Observation of bacterial motility - hanging drop method.
6. Simple staining of bacteria.
7. Gram's staining of bacteria.
8. Negative staining of bacteria.
9. Methylene blue reductase test for testing the quality of milk.
10. Test for antibiotic sensitivity.

**Slides/ Charts/ Models:**

Streptococcus, Salmonella, Corynebacterium, Clostridium, Influenza virus, Rabies virus, Hepatitis-B, HIV, Entamoeba, Aspergillus, root nodules (Rhizobium), Azolla, Ocular and stage micrometer, Autoclave, Laminar air flow.

**Ecobiology**

1. Measurement of primary productivity (O<sub>2</sub> measurement method).
2. Sampling of animal population using the quadrat method.
3. Observation of life table in an insect.
4. Collection and identification of freshwater planktons.

5. Measurement of turbidity using Secchi disc.
6. Determination of  $LC_{50}$  of a pesticide.
7. Estimation of  $H_2S$  in water sample.
8. Estimation of salinity in water sample.
9. Estimation of  $CO_2$  in water sample.
10. Study report of a pond ecosystem.

### **Specimen/ Chart/ Models**

Commensalisms (Shark and Echeineis), Mutualism (Sea anemone and Hermit crab),  
Food chain, Food web, Conventional energy source (coal) and non-conventional energy  
source (wind mill).

### **Biotechnology and Nanobiology**

1. Extraction of genomic DNA.
2. Estimation of DNA (DPA method).
3. Agarose gel electrophoresis in separation of DNA (démonstration only).
4. Polymerase chain reaction (démonstration only).
5. Bacterial culture and antibiotic sélection media.
6. Immobilization of yeast cells.
7. Préparation of wine. Estimation of éthanol content in wine.
8. Production of amylase by bacteria.

### **Flow charts/ Instruments/ Figures**

Plasmid DNA isolation, Insulin production by rDNA Technology, Hybridoma production,  
Synthesis of DNA nanoarray, Southern blotting, Biosensor (glucometer), Air-lift bioreactor,  
Bucky balls, Dendrimers.

**Semester IV**  
**PG - Self-Learning Course**  
**Life Science for Competitive Examinations – II**  
**Course Code: PZ17S2**

No of credits	Marks
2	100

**Objectives**

1. To enable the students to gather information on various topics in biology.
2. To face competitive examinations like UGC – CSIR, NET and other similar examinations.

**UNIT I Inheritance Biology:**

- A. Mendelian principles: Dominance, segregation, independent assortment.
- B. Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests
- C. Extensions of Mendelian principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.
- D. Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.
- E. Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance.
- F. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
- G. Human genetics: Pedigree analysis, Lod score for linkage testing, karyotypes, genetic disorders.
- H. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.
- I. Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis.
- J. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
- K. Recombination: Homologous and non-homologous recombination including transposition.

**UNIT II Diversity of Life forms:**

- A. Principles & methods of taxonomy:  
Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms.

**B. Levels of structural organization:**

Unicellular, colonial and multicellular forms. Levels of organization of tissues, organs & systems. Comparative anatomy, adaptive radiation, adaptive modifications.

**C. Outline classification of plants, animals & microorganisms:**

Important criteria used for classification in each taxon. Classification of plants, animals and microorganisms. Evolutionary relationships among taxa.

**D. Natural history of Indian subcontinent:**

Major habitat types of the subcontinent, geographic origins and migrations of species. Common Indian mammals, birds. Seasonality and phenology of the subcontinent.

**E. Organisms of health & agricultural importance:**

Common parasites and pathogens of humans, domestic animals and crops.

**F. Organisms of conservation concern:**

Rare, endangered species. Conservation strategies.

**UNIT III Ecological Principles:**

**A. The Environment:** Physical environment; biotic environment; biotic and abiotic interactions.

**B. Habitat and Niche:** Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

**C. Population Ecology:** Characteristics of a population; population growth curves; population regulation; life history strategies (*r* and *K* selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

**D. Species Interactions:** Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

**E. Community Ecology:** Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

**F. Ecological Succession:** Types; mechanisms; changes involved in succession; concept of climax.

**G. Ecosystem Ecology:** Ecosystem structure; ecosystem function; energy flow and mineral cycling (C,N,P); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

**H. Biogeography:** Major terrestrial biomes; theory of island biogeography; biogeographical zones of India.

**I. Applied Ecology:** Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches.

**J. Conservation Biology:** Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

**UNIT IV Evolution and Behaviour:**

**A. Emergence of evolutionary thoughts**

Lamarck; Darwin—concepts of variation, adaptation, struggle, fitness and natural selection; Mendelism; Spontaneity of mutations; The evolutionary synthesis.

**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.

**C. 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; Major groups of plants and animals; Stages in primate evolution including Homo.

**D. Molecular Evolution:**

Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence.

**E. 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.

**F. Brain, Behavior and Evolution:**

Approaches and methods in study of behavior; Proximate and ultimate causation; Altruism and evolution-Group selection, Kin selection, Reciprocal altruism; Neural basis of learning, memory, cognition, sleep and arousal; Biological clocks; Development of behavior; Social communication; Social dominance; Use of space and territoriality; Mating systems, Parental investment and Reproductive success; Parental care; Aggressive behavior; Habitat selection and optimality in foraging; Migration, orientation and navigation; Domestication and behavioral changes.

**Applied Biology:**

A. Microbial fermentation and production of small and macro molecules.

B. Application of immunological principles, vaccines, diagnostics. Tissue and cell culture methods for plants and animals.

C. Transgenic animals and plants, molecular approaches to diagnosis and strain identification.

D. Genomics and its application to health and agriculture, including gene therapy.

E. Bioresource and uses of biodiversity.

F. Breeding in plants and animals, including marker – assisted selection

G. Bioremediation and phytoremediation

H. Biosensors

**UNIT V Methods in Biology:**

A. Molecular Biology and Recombinant DNA methods;

- a) Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods.
- b) Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels.
- c) Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems.
- d) Expression of recombinant proteins using bacterial, animal and plant vectors.
- e) Isolation of specific nucleic acid sequences
- f) Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.
- g) In vitro mutagenesis and deletion techniques, genes knock out in bacterial and eukaryotic organisms.
- h) Protein sequencing methods, detection of post translation modification of proteins.
- i) DNA sequencing methods, strategies for genome sequencing.
- j) Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques
- k) Isolation, separation and analysis of carbohydrate and lipid molecules
- l) RFLP, RAPD and AFLP techniques

#### B. Histochemical and Immunotechniques:

Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flowcytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

#### C. Biophysical Method:

Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

#### D. Statistical Methods:

Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X<sup>2</sup> test;; Basic introduction to Multivariate statistics, etc.

#### E. Radiolabeling techniques:

Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

#### F. Microscopic techniques:

Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-

etch and freeze- fracture methods for EM, image processing methods in microscopy.

#### G. Electrophysiological methods:

Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT.

#### H. Methods in field biology:

Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization: ground and remote sensing methods.

### Reference Books

1. Vijay N. Waghmare (2004). *Life sciences for NET/SLET exams of UGC-CSIR*. Maharashtra: Mudra Publication.
2. Dr. A P Singh & Kumar Pushkar (2010). *CSIR-UGC NET/JRF/SLET Life Sciences (Paper I & II)*. New Delhi: Upkar Publishers.
3. Arun Chaudhary, B. L., Chaudhary and Kailash Choudhary (2007). *CSIR/NET Life Sciences*. New Delhi: New Age Publishers.
4. Kumar Pranav Mina Usha (2011). *CSIR-JRF-NET: Life Sciences Fundamentals and Practice (Part - I)*. New Delhi: Pathfinder Academy.
5. Ashish Nagesh, Quaiser J. Hossain, Prashant Kumar (2012). *UGC-CSIR NET (JRF & LS) Life Science*. Chennai: Arihant Publishers.
6. Rupendra Singh (2014). *CSIR NET/JRF Life Sciences* (4<sup>th</sup> ed.). Lucknow: Catalyst Center of Excellence Pvt. Ltd.
7. Pramod Singh (2014). *Trueman's UGC CSIR-NET Life Sciences*. New Delhi: Danika Publishing Company.
8. RPH (2014). *CSIR-UGC NET Life Science (Popular Master Guide): Life Sciences*, RPH Editorial Board.
9. Pranav Kumar (2013). *MCQs Life Sciences – Biotechnology* (3<sup>rd</sup> Ed.). New Delhi: Pathfinder Academy.

**M.Sc. Syllabus (2023 Board)**  
**SEMESTER I**

**CORE COURSE I: STRUCTURE AND FUNCTION OF INVERTEBRATES**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP231CC1	5	1	-	1	4	7	105	25	75	100

**Pre-requisite:**

Students should know the taxonomical classification of invertebrates in relation to their functional morphology.

**Learning Objectives:**

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

**Course Outcomes**

<b>On the successful completion of the course, student will be able to:</b>		
<b>CO1</b>	remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.	<b>K1</b>
<b>CO2</b>	understand the evolutionary process. All are linked in a sequence of life pattern	<b>K2</b>
<b>CO3</b>	apply this for pre-professional work in agriculture and conservation of life forms.	<b>K3</b>
<b>CO4</b>	analyze what lies beyond our present knowledge of life process.	<b>K4</b>
<b>CO5</b>	evaluate and to create the perfect phylogenetic relationship in classification.	<b>K5</b>

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

<b>Units</b>	<b>Contents</b>	<b>No. of Hours</b>
I	Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; New trends in taxonomy	21
II	organization of coelom: Acoelomates; Pseudocoelomates; Coelomates; Protostomia and Deuterostomes; Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata	21
III	Nutrition and Digestion: Patterns of feeding and digestion in lower	21



	metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Respiration: Organs of respiration: Gills, lungs and trachea; Respiratory pigments; Mechanism of respiration	
IV	Excretion: Organs of excretion: coelom, coelomoducts, Nephridia and Malpighian 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	21
V	Invertebrate larvae: Larval forms of free-living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. Minor Phyla: Concept and significance; Organization and general characters	21

### Text Books:

1. Ekambaranatha Iyer, 2000. A Manual of Zoology, 10<sup>th</sup> edition, Viswanathan, S., Printers & Publishers Pvt Ltd.
2. Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.
3. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

### Reference Books:

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.

### Web Resources

1. <https://www.uou.ac.in/sites/default/files/slm/MSZCO-501.pdf>
2. <https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/structure-and-function>
3. <https://www.zoologytalks.com/category/structure-and-functions-of- invertebrates/>
4. <https://www.bilasagirlscollege.ac.in/newsData/D54.pdf>

### MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	2	3	3	3	2
CO2	3	3	2	2	3	3	2
CO3	3	2	3	2	3	3	2
CO4	3	2	3	2	3	3	2
CO5	3	2	3	2	3	3	2
TOTAL	15	12	13	11	13	11	10
AVERAGE	3	2.4	2.6	2.2	2.6	2.2	2

3 – Strong, 2- Medium, 1- Low

### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	2
CO2	3	3	2	3	3
CO3	2	2	3	3	2
CO4	3	3	3	3	3
CO 5	2	2	2	2	2
<b>Total</b>	13	13	12	14	12
<b>Average</b>	2.6	2.6	2.4	2.8	2.4

### SEMESTER – I

#### CORE COURSE II: COMPARATIVE ANATOMY OF VERTEBRATES

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP231CC2	5	1	-	1	5	7	105	25	75	100

#### Pre-requisite:

Students with knowledge and comprehension on zoology

#### Learning Objectives:

1. To impart conceptual knowledge about the animal life in the air and their behaviours.
2. To understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.

#### Course Outcomes:

On successful completion of the course, the student will be able to:		
CO1	remember the general concepts and major groups in animal classification, origin, structure, functions, and distribution of life in all its forms.	K1
CO2	understand the evolutionary process. All are linked in a sequence of life patterns.	K2
CO3	apply this for pre-professional work in agriculture and conservation of life forms.	K3
CO4	analyze what lies beyond our present knowledge of life process.	K4
CO5	evaluate and to create the perfect phylogenetic relationship in classification.	K5

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

Unit	Contents	Hours
I	Origin of vertebrates: Concept of Protochordata; The nature of vertebratemorphology; Definition, scope and relation to other disciplines; Importance of the study of vertebratemorphology.	21

II	<b>Origin and classification of vertebrates:</b> Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs.	21
III	<b>General plan of circulation in various groups:</b> Blood; Evolution of heart; Evolution of aortic arches and portal systems. Respiratory system: Characters of respiratory tissue; Internal and external respiration; Comparative account of respiratory organs	21
IV	<b>Skeletal system:</b> Form, function, body size and skeletal elements of the body; Comparative account of jawsuspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrateseries.	21
V	<b>Sense organs:</b> Simple receptors; Organs of Olfaction and taste; Lateral line system; Electroreception. Nervous system: Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinal cord; Nerves-Cranial, Peripheral and Autonomous nervous systems.	21
<b>Self-Study</b>	Scope and relation of vertebrate morphology to other disciplines, Vertebrate integument and its derivatives, Evolution of aortic arches and portal systems, Comparative account of jawsuspensorium, Comparative anatomy of spinal cord	

#### **Text Books:**

1. Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.
2. Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.
3. Ayyar, E.K. and T.N. Ananthakrishnan, 1992. Manual of Zoology Vol. II (Chordata), S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras, 891p.
4. Jordan, E.K. and P.S. Verma, 1995. Chordate Zoology and Elements of Animal Physiology, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi, 1151 pp.
5. Ganguly, Sinha, Bharati Goswami and Adhikari, 2004. Biology of animals Vol.II - New central book Agency (p) Ltd.

#### **Reference Books:**

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.

#### **Web sources:**

1. Swayam Prabha: <https://www.swayamprabha.gov.in/index.php/program/archive/9>
2. <https://bit.ly/3Av1Ejg/>
3. <https://bit.ly/3kqTfYz/>
4. <https://biologyeducare.com/aves/>
5. <https://www.vedantu.com/biology/mammalia/>

#### **MAPPING WITH PROGRAMME OUTCOMES**

<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>CO1</b>	3	2	1	3	2	3	2
<b>CO2</b>	3	1	1	3	2	3	2
<b>CO3</b>	3	2	1	2	2	2	2
<b>CO4</b>	3	1	1	3	1	3	2
<b>CO5</b>	3	2	1	2	3	3	2
<b>Total</b>	15	8	5	13	10	14	10
<b>Average</b>	3	1.6	1	2.6	2	2.8	2

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

#### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

<b>COs</b>	<b>PSO1</b>	<b>PSO2</b>	<b>PSO3</b>	<b>PSO4</b>	<b>PSO5</b>
<b>CO1</b>	3	3	2	3	2
<b>CO2</b>	3	3	2	2	3
<b>CO3</b>	2	2	3	2	2
<b>CO4</b>	3	3	3	3	3
<b>CO 5</b>	2	3	2	2	2
<b>Total</b>	13	14	12	12	12
<b>Average</b>	2.6	2.8	2.4	2.4	2.4

### SEMESTER I

#### CORE LAB COURSE I: LAB COURSE IN INVERTEBRATES & VERTEBRATES

<b>Course Code</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>S</b>	<b>Credits</b>	<b>Inst. Hours</b>	<b>Total Hours</b>	<b>Marks</b>		
								<b>CIA</b>	<b>External</b>	<b>Total</b>
<b>ZP231CP1</b>	-	-	4		3	4	60	25	75	100

#### Pre-requisite

Basic knowledge on the animals living in different habitats

#### Learning Objectives:

1. Understanding the salient features and functional anatomy of different systems and the skeletal system in invertebrates & vertebrates.
2. Developing the skill in mounting techniques of the biological samples.

#### Course Outcomes

On the successful completion of the course, student will be able to:		
<b>CO1</b>	understand the structure and functions of various systems in	<b>K1</b>

	animals	
<b>CO2</b>	learn the adaptive features of different groups of animals	<b>K2</b>
<b>CO3</b>	learn the mounting techniques	<b>K3</b>
<b>CO4</b>	acquire strong knowledge on the animal skeletal system	<b>K4</b>

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

<b>INVERTEBRATES</b>	
<b>Dissection</b>	
Earthworm	: Nervous system
<i>Pila</i>	: Digestive and nervous systems
<i>Sepia</i>	: Nervous system
Cockroach	: Nervous system
Grasshopper	: Digestive system and mouth parts
Prawn	: Appendages, nervous and digestive systems
Crab	: Nervous system
<b>Study of the following slides with special reference to their salient features and their modes of life</b>	
1.	<i>Amoeba</i>
2.	<i>Entamoeba histolytica</i>
3.	<i>Paramecium</i>
4.	Hydra with bud
5.	Sporocyst – Liver fluke
6.	<i>Cercaria</i> larva
7.	Tape worm ( <i>Scolex</i> )
8.	<i>Ascaris</i> T. S.
9.	Mysis of prawn
<b>Spotters</b>	
1.	Scorpion
2.	<i>Penaeus indicus</i>
3.	<i>Emerita</i> ( <i>Hippa</i> )
4.	<i>Pernaviridis</i>
<b>Mounting</b>	
Earthworm	: Body setae
<i>Pila</i>	: Radula
Cockroach	: Mouth parts
Grasshopper	: Mouth parts

<b>VERTEBRATES</b>	
<b>Study the nervous system of Indian dog shark - Dissection</b>	
1.	Nervous system of <i>Scoliodonlaticaudatus</i> – 5 <sup>th</sup> or Trigeminal nerve
2.	Nervous system of <i>Scoliodonlaticaudatus</i> – 7 <sup>th</sup> or Facial nerve
3.	Nervous system of <i>Scoliodonlaticaudatus</i> – 9 <sup>th</sup> and 10 <sup>th</sup>

or Glossopharyngeal & Vagus nerve
<b>Study of the following specimens with special reference to their salient features and their modes of life</b>
<ol style="list-style-type: none"> <li>1. <i>Amphioxus</i> sp. (Lancelet)</li> <li>2. <i>Ascidia</i> sp. (sea squirt)</li> <li>3. <i>Scoliodon laticaudatus</i> (Indian dog shark)</li> <li>4. <i>Trygon</i> sp. (Sting ray)</li> <li>5. <i>Torpedo</i> sp. (Electric ray)</li> <li>6. <i>Arius maculatus</i> (Cat fish)</li> <li>7. <i>Belone cunctilata</i> (Flute fish)</li> <li>8. <i>Exocoetus poecilopterus</i> (Flying fish)</li> <li>9. <i>Mugil cephalus</i> (Mullet)</li> <li>10. <i>Tilapia mossambicus</i> (Tilapia)</li> <li>11. <i>Rachycentron canadum</i> (Cobia)</li> <li>12. <i>Tetrodon punctatus</i> (Puffer fish)</li> <li>13. <i>Dendrophis</i> sp. (Tree snake)</li> </ol>
<b>Study of the different types of scales in fishes</b>
<ol style="list-style-type: none"> <li>1. Cycloid scale</li> <li>2. Ctenoid scale</li> <li>3. Placoid scale</li> </ol>
<b>Study of the frog skeleton system (Representative samples)</b>
<ol style="list-style-type: none"> <li>1. Entire skeleton</li> <li>2. Skull</li> <li>3. Hyoid apparatus</li> <li>4. Pectoral girdle and sternum</li> <li>5. Pelvic girdle</li> <li>6. Fore limb</li> <li>7. Hind limb</li> </ol>
<b>Mounting</b>
<ol style="list-style-type: none"> <li>1. Weberian ossicles of fish</li> </ol>

**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. Chattopadhyay. 2011. Advanced Practical Zoology, Arunabha Sen Publishers, pp-1070.

**Web Resources:**

1. <http://www.csrtimys.res.in/>
2. <http://csb.gov.in/>
3. <https://iinrg.icar.gov.in/>
4. <https://www.nationalgeographic.com/animals/invertebrates/>

5. [https://www.youtube.com/watch?v=b04hc\\_kOY10](https://www.youtube.com/watch?v=b04hc_kOY10)
6. <https://bit.ly/3CzTEy8>
7. <http://tolweb.org/Chordata/2499>
8. <https://www.nhm.ac.uk/>

#### MAPPING WITH PROGRAMME OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	2	3	2	2
CO2	3	2	3	3	3	2	2	2
CO3	3	2	3	3	3	2	2	2
CO4	3	2	3	3	2	2	2	2
<b>TOTAL</b>	12	6	12	12	10	9	8	8
<b>AVERAGE</b>	3	1.5	3	3	2.5	2.25	2	2

3 – Strong, 2- Medium, 1- Low

#### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	2	3	3
CO2	3	3	2	2	3
CO3	2	2	3	2	2
CO4	3	3	3	3	3
<b>Total</b>	11	11	10	10	11
<b>Average</b>	2.75	2.75	2.5	2.5	2.75

### SEMESTER I

#### ELECTIVE COURSE - I

##### (a) MOLECULES AND THEIR INTERACTION RELEVANT TO BIOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC1	3	1	-	1	3	5	75	25	75	100

#### Pre-requisite:

Understanding fundamental properties of elements, atoms, molecules, chemical bonds, linkages and structure, composition, metabolism, and functions of biomolecules.

#### Learning Objectives

1. Students should know the fundamentals of biochemistry.
2. To develop analytical and communicative skills to conduct experiments and interpret the results

#### Course Outcome

<b>On the successful completion of the course, student will be able to:</b>
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<b>CO1</b>	learn the structure, properties, metabolism, and bioenergetics of biomolecules	<b>K1</b>
<b>CO2</b>	acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation	<b>K2</b>
<b>CO3</b>	understand the fundamentals of biophysical chemistry and biochemistry, importance, and applications of methods in conforming the structure of biopolymers	<b>K3</b>
<b>CO4</b>	comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids	<b>K4</b>
<b>CO5</b>	familiarize the use of methods for the identification, characterization, and conformation of biopolymer structures	<b>K5</b>

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

<b>Units</b>	<b>Contents</b>	<b>No. of Hours</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).	15
<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).	15
<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	15
<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).	15
<b>V</b>	Stabilizing interactions in biomolecules: Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions and disulfide linkage.	15

<b>Self-study</b>	Structure of atoms, Hydrophobic interactions, Glycolysis t-RNA, Nucleic acid structures
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#### **Text Books**

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





ZP231EC2	3	1	-	1	3	5	75	25	75	100
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**Pre-requisite:**

Students should know the fundamentals of natural science and have a curiosity of criminology.

**Learning Objectives:**

1. Students should emphasize the importance of scientific methods in crime detection and disseminate information on the advancements in the field of forensic science.
2. Derive to skills to identify crime through various forensic techniques

**Course Outcomes**

On the successful completion of the course, student will be able to		
<b>CO1</b>	recall the fundamentals of forensic biology, psychology, and criminal profiling.	<b>K1</b>
<b>CO2</b>	outline the use of scientific evidence in a legal context using basic facts, fundamental principles, and functions of forensic science.	<b>K2</b>
<b>CO3</b>	apply the knowledge gained on forensic, dermatoglyphic, serological and odonatological techniques to render forensic service during real-time crime scenes.	<b>K3</b>
<b>CO4</b>	analyze fingerprints, personal identification evidence, bite marks and pug marks.	<b>K4</b>
<b>CO5</b>	evaluate information to find strategies to resolve problems in forensic biology.	<b>K5</b>

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

Units	Contents	No. of Hours
<b>I</b>	Concepts and scope, functions, and historical aspects of forensic science. Importance, nature, location, collection and preservation of biological exhibits and crime scene investigation of biological evidence. Forensic dermatoglyphics - biological basis of fingerprints, formation of ridges, fundamental principles of fingerprinting, types of fingerprints, fingerprint patterns, automated fingerprint identification system.	15
<b>II</b>	Forensic examination of hair - importance, nature, location, structure, growth phases of hair, collection, evaluation, and tests for their identification. Forensic Serology - identification of body fluids, collection and preservation of blood evidence, distinction between human and non-human blood, semen - forensic significance of semen, composition and morphology of spermatozoa, collection, evaluation and tests for identification of semen. Composition and forensic significance of saliva, sweat, milk and urine.	15
<b>III</b>	Structural variation, types of teeth - human and non-human teeth, determination of age from teeth, eruption sequence, dental anomalies, their significance in personal identification. Bite marks - forensic significance, collection and preservation of bite marks, photography and evaluation of bite	15

	marks, lip prints in forensic investigations.	
IV	Forensic Entomology - insects of forensic importance, collection of entomological evidence during death investigations. The role of aquatic insects in forensic investigations, insect succession on carrion and its relationship to determine time since death, factors influencing insect succession on carrion, its application to forensic entomology. Forensic Microbiology - types and identification of microbial organisms of forensic significance.	15
V	Importance of Wildlife Protection Act-1972- Schedules in the protection of endangered species of flora and fauna. Identification of wildlife materials such as skin, fur, bones, nails, horn, teeth, plants, plant parts and products by conventional and modern methods. Identification of pug marks of various animals, DNA techniques in wildlife investigations.	15

<b>Self-study</b>	Historical aspects of fingerprints, Collection, and preservation of blood Types of teeth, Forensic microbiology, DNA techniques
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#### Text Books:

1. S. Chowdhuri (1971). *Forensic Biology*. New Delhi: BPRD.
2. R. Saferstein (1993). *Forensic Science Handbook* (Vol. 3). New Jersey: Prentice Hall.

#### References

1. R.S. Ramotowski (2013). Lee and Gaenslen's, *Advances in Fingerprint Technology* (3rd ed.). Boca Raton: CRC Press.
2. L. Stryer, (1988). *Biochemistry* (3rd ed.). New York: W.H. Freeman and Company.
3. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell, (1993). *Harper's Biochemistry*. Norwalk: APPLETON and Lange.
4. M. Bernstein (1997). *Forensic odontology in, Introduction to Forensic Sciences* (2nd ed.), W.G. Eckert (Editor). Boca Raton: CRC Press.
5. J. Dix (1999). *Handbook for Death Scene Investigations*. Boca Raton: CRC Press.
6. V.J. Geberth, (2006). *Practical Homicide Investigation*. Boca Raton: CRC Press.
7. W.G. Eckert and S.H. James (1989). *Interpretation of Bloodstain Evidence at Crime Scenes*. Boca Raton: CRC Press.
8. G.T. Duncan and M.I. Tracey (1997). *Serology and DNA typing in, Introduction to Forensic Sciences* (2nd ed.), W.G. Eckert (Editor.). Boca Raton: CRC Press.

#### Web Resources:

1. <http://www.dnaftb.org/>
2. <https://forensidental.wordpress.com/>
3. <https://www.forensicsciencesimplified.org/>
4. <http://www.istl.org/03-spring/internet.html>

#### MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	1	2	3	1	3
CO 2	3	2	2	2	2	1	3
CO 3	3	3	2	2	3	2	3
CO 4	3	2	1	1	3	2	2
CO5	2	2	3	3	2	3	3
<b>Total</b>	14	12	9	10	13	9	14
<b>Average</b>	2.8	2.4	1.8	2	2.6	1.8	2.8

3 – Strong, 2 – Medium, 1 - Low

#### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	3	2	2	3
CO3	2	2	3	2	2
CO4	3	3	3	3	3
CO5	3	2	2	3	3
<b>Total</b>	13	13	13	13	14
<b>Average</b>	2.8	2.6	2.6	2.6	2.8

#### SEMESTER: I

#### ELECTIVE COURSE - I

#### (c) WILDLIFE CONSERVATION AND MANAGEMENT

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC3	3	1	-	1	3	5	75	25	75	100

#### Pre-requisite:

Students should know the importance of wild-life and be responsible to conserve the environment and the ecosystem.

#### Learning Objectives

1. To equip students with adequate knowledge of various biodiversity monitoring methodologies, conservation, and management
2. To identify the issues of vertebrate pests, wildlife conflict and over abundant species, wildlife health and diseases.

#### Course Outcomes

On the successful completion of the course, student will be able to:		
CO1	develop the ability to use the fundamental principles of wildlife ecology to solve local, regional and national conservation and management issues	<b>K1</b>
CO2	develop the ability to work collaboratively on team-based projects	<b>K2</b>
CO3	demonstrate proficiency in the writing, speaking, and critical thinking skills needed to become a wild life technician	<b>K3</b>

<b>CO4</b>	gain an appreciation for the modern scope of scientific inquiry in the field of wild life conservation management	<b>K4</b>
<b>CO5</b>	develop an ability to analyze, present and interpret wildlife conservation management information.	<b>K5</b>

<b>U ni ts</b>	<b>Contents</b>	<b>No. of Hours</b>
<b>I</b>	Definition and importance of wildlife; Types of ecosystems. Causes of depletion of wildlife; Classification of wetland and animal inhabitants; Population vulnerability analysis and its components; Factors responsible for the extinction of animals; Types of protected areas and the concept of zoning within the protected areas.	15
<b>II</b>	Wildlife Sanctuaries and National Parks in India: Theories of population dispersal; Animal movement, concept of home range and territory; Tracking movement by remote sensing and GIS. Wildlife conservation, ethics and importance of conservation; Impact of habitat destruction and fragmentation on wildlife; Biological parameters such as food, cover, forage and their impact on wild life;	15
<b>II I</b>	Population attributes; concepts of exponential and logistic growth rates of wildlife; Density dependent and independent population regulation; Impact of introduced species on preexisting flora and fauna of wildlife; Identification and estimation of wild animals by fecal sample analysis, hair identification, pugmarks and census methods. Predator-prey models and impact of predation.	15
<b>I V</b>	Wildlife conservation objectives- Captive breeding techniques and translocation and reintroduction; Inviolate areas and critical habitats and their impact on wildlife; Different terrestrial habitats of wildlife in India; Restoration of degraded habitat. Damage caused by wildlife in India and its mitigation; Sick animal refuges in protected areas. Type of wildlife management- manipulative, custodial; Management of over abundant wild animal populations causing damages to nearby inhabitants and their crops and animals;	15
<b>V</b>	Tools and techniques to control the menace of wild animals; man, wildlife conflict resolution and mitigation; Management of exotic and invasive wetland species in India. Habitat manipulation- control and regulation of grazing. Weed eradication; Major diseases of domestic and wild animals and their control and impact of wild life tourism.	15

<b>Self-study</b>	Types of ecosystems, Wild life sanctuaries and national parks in India, Wild life conservation, Weed eradication
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#### **Text Books**

1. Caughley, G., and Sinclair, A.R.E. (1994) *Wildlife Ecology and Management*. Blackwell Science.
2. Goutam Kumar Saha & Subhendu Mazumdar (2017). *Wildlife Biology: An Indian Perspective*. New Delhi: PHI Learning Pvt. Ltd.

- Singh, S.K (2015). *Textbook of wildlife management* (2<sup>nd</sup> ed.). Delhi: CBS Publishers and Distributors Pvt. Ltd.

### Reference Books

- Woodroffe, R., Thirgood, S. and Rabinowitz, A. (2005) *People and Wildlife, Conflict or Co-existence?* Cambridge University.
- Bookhout, T.A. (1996) *Research and Management Techniques for Wildlife and Habitats* (5<sup>th</sup> edition) The Wildlife Society, Allen Press.
- Sutherland, W.J. (2000) *The Conservation Handbook: Research, Management and Policy*. Blackwell Sciences
- Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008) *Problem Solving in Conservation Biology and Wildlife Management: Exercises for Class, Field, and Laboratory*. Blackwell Publishing.
- Taj Rawat (2012). *Biodiversity Conservation and Wildlife Tourism*. Delhi: Discovery Publishing House Pvt. Ltd.
- Kumar, U. & Asija, M.J. (2007). *Biodiversity - Principle and Conservation* (2<sup>nd</sup> ed.). Jodhpur Student Editors.
- Seshadiri Balakrishnan, (1969). *The Twilight of India's Wildlife*. Chennai: Oxford University Press.
- Gee, E.P. (1969). *Wildlife in India* (1<sup>st</sup> ed.). London: Collins Foundation Books.
- Anthony R.E. Sinclair, John M. Fryxell & Graeme Caughley (2006). *Wildlife Ecology, Conservation, and Management* (2<sup>nd</sup> ed.). USA: Blackwell Publishing.

### Web Sources

- <https://education.nationalgeographic.org/resource/wildlife-conservation/>
- <https://www.clearias.com/wildlife-conservation-projects/>
- <https://www.wii.gov.in/>
- <https://www.mdpi.com/2673-7159/1/2/9>

### MAPPING WITH PROGRAMME OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	3	3	2	2
CO2	3	2	3	3	3	2	2
CO3	3	2	3	3	3	2	2
CO4	3	2	3	3	3	2	2
CO5	3	2	3	3	3	2	2
TOTAL	15	10	15	15	15	10	10
AVERAGE	3	2	3	3	3	2	2

3 – Strong, 2- Medium, 1- Low

### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3

<b>CO2</b>	2	3	2	2	3
<b>CO3</b>	2	2	3	2	2
<b>CO4</b>	3	3	3	3	3
<b>CO5</b>	3	2	2	3	3
<b>Total</b>	13	13	13	13	14
<b>Average</b>	2.8	2.6	2.6	2.6	2.8

**SEMESTER I**  
**ELECTIVE COURSE –IIa)BIOSTATISTICS**

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
<b>ZP231EC4</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>75</b>	<b>25</b>	<b>75</b>	<b>100</b>

**Pre-requisite:**

Students should be aware of the importance of analysis of quantitative and qualitative information from biological studies

**Learning Objectives:**

The main objectives of this course are:

1. To enable the students to understand the basic concepts in Biostatistics and analyse the data to derive inferences in various biological experiments.
2. To develop analytical skills of statistics and draw valid conclusions in research.

**Course outcomes**

COs	Upon completion of this course the students will be able to:	CL
<b>CO1</b>	recall different biological data, methods of collection and analysis of data.	<b>K1</b>
<b>CO2</b>	comprehend the design and application of biostatistics relevant to experimental and population studies.	<b>K2</b>
<b>CO3</b>	acquire skills to perform various statistical analyses using modern statistical techniques and software.	<b>K3</b>
<b>CO4</b>	analyze the data and interpret the results manually or by using software	<b>K4</b>
<b>CO5</b>	evaluate 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</b>

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

Units	Content	No. of hours
<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	15

	pie chart.	
II	Measures of central tendency: Mean, median and mode for continuous and discontinuous variables. Measures of dispersion: Range, variation, standard deviation, standard error, and coefficient of variation.	15
III	Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions.	15
IV	Hypothesis testing: Student 't' test - paired sample and mean difference 't' tests. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Significance test for correlation coefficients. Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction.	15
V	Analysis of variance: one way and two-way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS).	15

<b>Self-Study</b>	Graphic methods: Frequency polygon and ogive curve; Diagrammatic representation: Histogram, bar diagram, pictogram and pie chart.
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#### Textbooks

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

#### Reference books

1. Pillai, R.S.N. and V. Bagavathi (2016). *Statistics Theory and Practice* (8<sup>th</sup>ed.). New Delhi: S. Chand Publishing Company Ltd.
2. Khan, I. and Khanum, A. (2014). *Fundamentals of Biostatistics* (3<sup>rd</sup> ed.): Hyderabad. Ukaaz Publications.
3. Zar, J.H. (1984). *Biostatistical Analysis* (2<sup>nd</sup> ed.). London: Prentice-Hall International Inc.
4. Bailey, N.T.J. (1997). *Statistical methods in Biology* (3<sup>rd</sup> ed.). New York: Cam. University Press.
5. Sokal, R. and James, F. (1973). *Introduction to Biostatistics*. Tokyo, Japan: W.H. Freeman and Company Ltd.
6. Daniel, W.W. (1987). *Biostatistics: A foundations for Analysis in the Health Sciences*. New York: John Wiley & Sons.
7. Gupta, S.P. (1998). *Statistical Methods*. New Delhi: S. Chand and Company Ltd.
8. Banerjee, P.K. (2005). *Introduction to Biostatistics*. New Delhi: S. Chand and Company Ltd.
9. Pranab Kumar Banerjee (2009). *Introduction to Biostatistics*, New Delhi:



S. Chand and Company Ltd.

### Web Resources

1. [https://faculty.ksu.edu.sa/sites/default/files/introduction\\_to\\_biostatistics-106.pdf](https://faculty.ksu.edu.sa/sites/default/files/introduction_to_biostatistics-106.pdf)
2. [https://www.youtube.com/watch?v=1Q6\\_LRZwZrc](https://www.youtube.com/watch?v=1Q6_LRZwZrc)
3. [https://www.youtube.com/watch?v=7CqolAC\\_owc](https://www.youtube.com/watch?v=7CqolAC_owc)
4. <https://www.ibm.com/docs/en/spss-statistics/25.0.0?topic=tutorial>
5. <https://www.statisticshowto.com/probability-and-statistics/spss-tutorial-beginners/>

### MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO 1</b>	3	1	1	x	1	1	3
<b>CO 2</b>	3	3	2	1	2	2	3
<b>CO 3</b>	3	2	2	x	x	3	3
<b>CO 4</b>	3	2	1	1	2	3	3
<b>CO 5</b>	3	3	2	2	2	3	3
<b>TOTAL</b>	15	11	8	4	7	12	15
<b>AVERAGE</b>	3	2.2	1.6	0.8	1.4	2.4	3

S-Strong (3) M-Medium (2) L-Low (1)

### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
<b>CO1</b>	3	3	3	3	3
<b>CO2</b>	2	3	3	2	3
<b>CO3</b>	2	3	3	3	2
<b>CO4</b>	3	3	3	3	3
<b>CO5</b>	3	2	3	3	3
<b>Total</b>	13	14	15	14	14
<b>Average</b>	2.6	2.8	3	2.8	2.8

## SEMESTER I

### ELECTIVE COURSE - II (b) APPLIED ZOOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
<b>ZP231EC5</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>1</b>	<b>3</b>	<b>5</b>	<b>75</b>	<b>25</b>	<b>75</b>	<b>100</b>

#### Prerequisite:

A genuine passion towards the culture of economically important cultivable organisms.

#### Learning Objectives

1. To deepen the knowledge of students in general and applied areas of Zoology.
2. To provide employment and job opportunities in the public, private and government sector.

#### Course Outcomes

**Upon completion of this course the students will be able to:**

CO - 1	apply the knowledge of animal husbandry in economic	<b>K1</b>
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	development.	
CO - 2	identify the kinds of bees and the methods of bee keeping.	<b>K2</b>
CO - 3	rear silkworms, harvest and market the cocoons.	<b>K3</b>
CO - 4	apply skills and experience about the management of poultry and Dairy farming.	<b>K4</b>
CO - 5	culture of economically important finfish and shell fishes.	<b>K5</b>

Units	Content	hours
I	<b>Apiculture:</b> Scope–classification and kinds of bees–bees and their society–life cycle of <i>Apis indica</i> –food of honey bees - relationship between plants and bees. Methods of bee keeping(primitive and modern) – Honey bee products: honey, bee wax, bee venom. <b>Lac culture</b> – scope – lac insect <i>Lacciferlacca</i> and its life cycle – processing of lac - lac products and importance.	15
II	<b>Sericulture:</b> Scope–Silk Road - CSB - Moriculture: varieties of mulberry, methods of propagation, harvesting of leaves – Common species of Silkworm– Life cycle of mulberry silkworm – Diseases of silkworm: pebrine, grasserie, sotto diseases, muscardine – pest of silkworm: uzifly. Rearing of silkworm – mounting – spinning - harvesting of cocoons – silk reeling and marketing.	15
III	<b>Poultry Keeping:</b> Scope–commercial layers and broilers - poultry housing - types of poultryhouses – management of chick, growers, layers and broilers – debeaking - sexing in chicks - Nutritive value of egg. Diseases of poultry – Ranikhet, Fowl pox, Coryza, Coccidiosis, Polyneuritis – vaccination.	15
IV	<b>Dairy Farming:</b> Scope–Breeds of Dairy animals–Establishment of a typical Dairy farm–Management of cow (Newborn, calf, Heifer, milking cow) – Diseases (Mastitis, Rinder Pest, FMD). Nutritive value of milk - dairy products (Standard milk, skimmed milk, toned milk and fermented milk-curd, ghee, cheese) Pasteurization. Leather industry – scope – processing of skin.	15
V	<b>Integrated Farming:</b> Definition and Scope.Agri-based fish farming–paddy cum fish culture–Horticulture-cum-fish farming. Integrated bee keeping - Live-stock fish farming - Duck-cum fish culture, fish-cum poultry farming, fish cum dairy farming, goat-cum fish integration, fish cum pig farming - multi-trophic aquaculture – Livestock – Poultry – Fish – Horticulture	15

### Text Books

Arumugam, N., Murugan, T., Johnson Rajeshwar, J. and Ram Prabhu, R. (2011). *Applied Zoology*. Nagercoil: Saras Publications.

### Reference Books

1. Vasantharaj David, B. (2004). *General and Applied Entomology* (2<sup>nd</sup> ed.). New Delhi: Tata McGraw-Hill Publishing Company Ltd.
2. Johnson, J. and Jeya Chandra, I. (2005). *Apiculture*. Marthandam: Olympic Grafix.

3. Tharadevi, C.S., Jayashree, K.V. and Arumugam, N. (2014). *Bee Keeping*. Nagercoil : Saras Publications.
4. Johnson, M. and Kesary, M. (2015). *Sericulture* (5<sup>th</sup> ed.). Marthandam: CSI Press.
5. Ganga, G. and Sulochana Chetty (1997). *An Introduction to Sericulture*. Delhi: Oxford and IBH Publishing Co. Pvt. Ltd.
6. Gnanamani, M.R. (2005). *Profitable Poultry Farming*. Madurai: J. Hitone Publications.
7. Shukla, G.S. and Upadhyay, V.B. (1998). *Economic Zoology*. Jaipur: Rastogi Publications.
8. John Moran (2005). *Tropical Dairy Farming*. Australia: Landlinks Press.
9. Uma Shankar Singh (2008). *Dairy Farming*. New Delhi: Anmol Publishers.

#### Web Resources

1. <https://guides.library.charlotte.edu/c.php?g=173165&p=1142033>
2. <https://www.slideshare.net/ManoKhan88/1-basic-concepts-in-economic-zoologypptx>
3. <https://egov.uok.edu.in/elearning/tutorials/1011020512BR15103CR15Apiculture%20Lac%20culture%20and%20%20sericultureapiculture%20lac%20culture%20and%20%20sericulture%20upload.pdf>
4. <https://www.echocommunity.org/en/resources/e7940e6c-ebbb-4b78-9115-fa5de38fa0d7>
5. <https://www.fao.org/documents/card/en?details=cb5353en>

#### MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO 1</b>	3	1	1	-	1	1	3
<b>CO 2</b>	3	3	2	1	2	2	3
<b>CO 3</b>	3	2	2	-	-	3	3
<b>CO 4</b>	3	2	1	1	2	3	3
<b>CO 5</b>	3	3	2	2	2	3	3
<b>TOTAL</b>	15	11	8	4	7	12	15
<b>AVERAGE</b>	3	2.2	1.6	0.8	1.4	2.4	3

S-Strong (3) M-Medium (2) L-Low (1)

#### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
<b>CO1</b>	3	3	3	3	3
<b>CO2</b>	2	3	3	2	3
<b>CO3</b>	2	3	3	3	2
<b>CO4</b>	3	3	3	3	3
<b>CO5</b>	3	2	3	3	3
<b>Total</b>	13	14	15	14	14
<b>Average</b>	2.6	2.8	3	2.8	2.8

**SEMESTER I**  
**ELECTIVE COURSE – II(c) PEST MANAGEMENT**

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EC6	3	1	-	1	3	5	75	25	75	100

**Prerequisite:**

Need to have a fundamental understanding of entomology, plant pathology, and integrated pest management strategies.

**Learning Objectives**

1. To provide awareness on various pests and their control measures.
2. To apply Integrated Pest Management strategies to resonate home based food products with the general public.

**Course Outcomes**

CO	Upon completion of this course the students will be able to:	
CO - 1	outline the pest groups affecting different agricultural crops and control measures.	<b>K1</b>
CO - 2	select correct IPM in cropping systems with traditional and alternative control measures.	<b>K2</b>
CO - 3	analyze the impact of pesticides on environment and adopt better agricultural practices.	<b>K3</b>
CO - 4	evaluate the control measures adopted for pests of household and stored products.	<b>K4</b>

Units	Content	No. of hours
<b>I</b>	<b>Introduction:</b> definition of pest–outline of pest groups affecting agricultural crops–population dynamics of pests – causes for pest outbreaks. Pest control methods: cultural, chemical and biological - pesticides, precautions, safety devices - pesticide poisoning symptoms and first aid.	15
<b>II</b>	<b>Pesticides:</b> organochlorine, organophosphorus and organocarbamates–inorganic and natural pesticides. Preparation of pesticides: formulations – packages, manufacture. Toxicity levels – LD <sub>50</sub> values. Mode of action of pesticides.	15
<b>III</b>	<b>Pests of Agricultural importance:</b> bionomics and life cycles of any two pests of the following: cereals (rice); oilseeds (coconut, groundnut); vegetables (brinjal); pulses; plantation crops (coffee); fruits (citrus) and pesticide formulations.	15
<b>IV</b>	<b>Household pests and Pests of stored products:</b> household pests (cockroaches, termites, silverfish, flies and mosquitoes) and their control measures. Rodents as pests – local rodents, life history, feeding habits, reproduction, and behaviour – methods of rodent control. Stored grain pest (rice weevil, flour beetle, cigarette beetle).	15

<b>V</b>	<b>Mode of Pest Control:</b> Pesticide spraying appliances. Residual toxicity of pesticides–Environment degradation and its prevention. Biological control of pest – parasites, predators, and pathogens – chemosterilants – pheromones - Baculovirus-mediated pest control. Integrated pest management and its relevance to 21 <sup>st</sup> century.	15
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### 1. Text Book

Dhawan, A.K., Balwinder Singh, Manmeet B Bhullar (2012). *Integrated Pest Management*. Chennai: Scientific Publishers.

### Reference Books

1. Nayar, Ananthkrishnan and David (1976). *General and Applied Entomology*. New Delhi: Tata McGraw Hill Publishers.
2. Metcalf and Flint (1973). *Destructive and useful Insects* (4<sup>th</sup> ed.). New Delhi: Tata McGraw Hill Publishers.
3. Roy, D.N. and Abrown, A.W. (1981). *Entomology: Medical and Veterinary* (3<sup>rd</sup> ed.). Bangalore: The Bangalore Printing and publishing company.
4. Cremllyn, R. (1979). *Pesticides: Preparation and mode of Action*. New Jersey: John Wiley & Sons Ltd.
5. Ignacimuthu, S. and B V David (2009). *Ecofriendly Insect Pest Management*. Delhi: Elite Publishing House Pvt Ltd (Ind).

### Web Sources

1. <https://guides.library.cornell.edu/c.php?g=672215&p=4733120>
2. <https://growingsmallfarms.ces.ncsu.edu/growingsmallfarms-insectlinks/>
3. <https://content.ces.ncsu.edu/insect-and-related-pests-of-vegetables>
4. <https://content.ces.ncsu.edu/insect-management-on-organic-farms>
5. <https://www.epa.gov/ipm/integrated-pest-management-tools-resources-support-ipm-implementation>

### MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
<b>CO 1</b>	3	1	1	x	1	1	3
<b>CO 2</b>	3	3	2	1	2	2	3
<b>CO 3</b>	2	2	3	2	3	3	3
<b>CO 4</b>	3	2	3	1	2	3	3
<b>TOTAL</b>	11	8	9	4	8	9	12
<b>AVERAGE</b>	2.75	2	2.25	0.8	2	2.25	5

S-Strong (3) M-Medium (2) L-Low (1)

### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
<b>CO1</b>	3	3	3	3	3
<b>CO2</b>	2	3	3	2	3
<b>CO3</b>	2	3	3	3	2
<b>CO4</b>	3	3	3	3	3

<b>Total</b>	10	12	12	11	11
<b>Average</b>	2.5	3	3	2.5	2.5

**SEMESTER I**  
**ELECTIVE LAB COURSE I: MOLECULES AND THEIR INTERACTION**  
**RELEVANT TO BIOLOGY & BIOSTATISTICS**

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP231EP1	-	-	2		2	2	30	25	75	100

**Pre-requisite**

Basic practical knowledge on the molecules and their interaction to animal body and analysis of quantitative and qualitative information from biological samples.

**Learning Objectives:**

1. Understanding the salient features and functional anatomy of different systems and the skeletal system in invertebrates & vertebrates.
2. To design experimental problems, analyze and evaluate critically with inferential biostatistics.

**Course Outcomes**

COs	Upon completion of this course the students will be able to:	KL
CO1	learn and study of chemical and physical structure of biological macromolecules.	K1
CO2	analyze the biomolecules and physicochemical parameters in samples	K2
CO3	analyze and interpret the collected data using statistical methods	K3
CO4	design biological experiments and evaluate the samples applying appropriate statistical methods.	K4

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

**Molecules and their Interaction Relevant to Biology**

1. Colorimetry-Verification of Beer-Lambert's law.
2. Preparation of solutions in normality, percentage, ppt, ppm
3. Quantitative estimation of glucose (Blood/ tissue) Standard graph method
4. Determination of velocity of salivary amylase activity by applying Michaelis - Menten equation.
5. Determination of pH of unknown solution using Known pKa – Application of Henderson-Hasselbalch equation.

**Instruments/Charts/Models:** Colorimeter, pH Meter, Centrifuge, Chromatogram, PAGE

**Biostatistics**

6. Measures of central tendency: mean, median and mode.
7. Measures of dispersion- Standard deviation and standard error.
8. Correlation coefficient: Length and width of molluscan shells

## Reference Books

1. Geetha K. Damodaraan, 2010. Practical Biochemistry. Jaypee Brothers Medical Publishers Pvt. Ltd.
2. Divya Shanthi, 2018. An easy guide for practical Biochemistry. Jaypee Brothers Medical Publishers Pvt. limited, 01-Nov-2008 -
3. Gupta, S.P.(1998). Statical methods. New Delhi: S. Chand and Company Ltd.
- 4, Gurumani, N. An introduction to Biostatistics. 2004. MJP publishers, Triplicane, Chennai.

## MAPPING WITH PROGRAMME OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO 1	3	3	1	2	3	1	3
CO 2	3	2	2	2	2	1	3
CO 3	3	3	2	2	3	2	3
CO 4	3	2	1	1	3	2	2
Total	12	10	6	7	11	6	11
Average	3	2.5	1.5	1.75	2.75	1.5	2.75

3 – Strong, 2- Medium, 1- Low

## MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	2	3	2	2	3
CO3	2	2	3	3	2
CO4	3	3	3	3	3
CO5	2	2	3	3	3
Total	12	12	14	14	14
Average	2.4	2.4	2.8	2.8	2.8

## SEMESTER I

### SPECIFIC VALUE ADDED COURSE

#### BASICS OF EXCEL

Course Code	Credits	Total Hours	Total Marks
ZP231V01	1	30	100

#### Prerequisite:

Basic computer literacy and familiarity with navigating computer applications.

**Objectives:**

To equip the students to present data using Excel's various features and printing options.

COs	On completion of this course, students will be able to	KL
CO 1	recall the components of Excel's interface and basic cell formatting.	K1
CO 2	summarize the significance of relative, absolute, and mixed cell references in formulae.	K2
CO 3	apply data entry techniques and utilize basic calculations and formulas.	K3
CO 4	analyze different chart types to determine their suitability for presenting specific types of data.	K3
CO 5	evaluate the effectiveness of using functions and charts to ensure clarity and effective visualization.	K5
CO 6	design and create various types of charts (bar, column, pie) based on specific data sets.	K6

**Unit 1: Excel Essentials and Interface:** Introduction to Excel's - Excel interface, workbooks, and sheets – selection of cells, rows, and columns - basic cell formatting: font, alignment, and fill.

**Unit 2: Data Entry, Formulas, and Functions:** Data entry techniques and AutoFill - Introduction to formulas and basic calculations - Using SUM, AVERAGE, COUNT, and other functions - cell references: relative, absolute, and mixed.

**Unit 3: Data Management and Analysis:** Sorting and filtering data using find and replace to manipulate data – Data analysis using excel (t test, Regression, Correlation, ANOVA), data validation for data integrity.

**Unit 4: Charts and visualization:** Creating different chart types: bar, column, and pie charts - formatting and enhancing charts for clarity - Adding labels, titles, and legends to charts.

**Unit 5: Printing, Sharing, and Review:** Setting up print options and page layout - printing worksheets and workbooks - sharing workbooks via email and cloud storage - review of key concepts and practical exercises.

**Reference books:**

1. Kabir Das. 2021. Microsoft Excel: Short keys and formulas. Notion Press, India.
2. Maneet Singh Mehta. 2021. Microsoft Excel Professionals. 2021 guide. BPB Publications, India.
3. Lokesh Lalwani. 2019. Excel 2019 – All in one. 1<sup>st</sup>Edn. BPB Publications, India.
4. John Walkaenbach. 2015. Microsoft Excel 2016 Bible – Comprehensive tutorial resource. John Wiley and Sons, Indiana.
5. Greg Harvey. 2016. Microsoft Excel 2016. DummiesPublisher



## SEMESTER II

### CORE COURSE III: CELLULAR AND MOLECULAR BIOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP232CC1	4	1	-	1	5	6	90	25	75	100

#### Pre-requisite

Students should have knowledge of the basic cellular structures and their salient functions.

#### Learning Objectives

1. To acquire knowledge on molecular organization of the cell and cell organelles, growth, and communications.
2. To develop skills needed to innovate and contribute to the advancement in cell and molecular biology.

#### Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall general concepts of cell biology and fundamental cellular structures and organelles.	K1
2.	explain the various cellular components and their activities.	K2
3.	identify the changes or losses in cell function caused by dysregulation.	K3
4.	compare different cellular processes, their regulation, and their significance.	K4
5.	assess the societal and environmental impacts through cellular and molecular research.	K5

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

Units	Contents	No. of Hours
I	General features of the cell: Cell theory; Diversity of cell size and shapes. Protoplasm and deutroplasm – cell organelles; Membrane structure and functions - membrane models, membrane/channel proteins, diffusion, osmosis, active transport, ion pumps (Sodium and potassium pump).	18
II	Cell organelles: Ultra-structure and functions of intracellular organelles – nucleus, nuclear pore complex, nucleolus, chromosomes, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, centrosomes, peroxisomes, ribosomes.	18
III	Cell cycle and cell division: Phases of Cell Cycle – Mitosis, Significance of Mitosis - meiosis, significance of meiosis. Control	18

	of the cell cycle - regulator molecules - positive regulation - negative regulation. Structure of DNA and RNA; Process of DNA replication, transcription, and translation in pro- and eukaryotic cells.	
IV	Cell communication and cell signaling: Membrane - associated receptors for peptide and steroid hormones - signaling through G-protein coupled receptors, signal transduction pathways (RTK pathway and MAP kinase pathway). Gap junction and tight junction, extracellular space and matrix, interaction of cells with other cells and non-cellular structures.	18
V	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 – mechanism and regulation. Ageing and senescence.	18

<b>Self-study</b>	Diversity of cell size and shapes, Ultra-structure and functions of lysosomes, Stages in cell cycle, Gap junction and tight junction, Characteristic features of normal and cancer cells.
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### Textbooks

1. Plopper, G., D. Sharp, and E. Sikorski. 2015. *Lewin's Cells* (Third Edition), Jones & Bartlett, New Delhi.
2. Ajoy Paul, 2011. *Textbook of Cell and Molecular Biology*, Books and Allied Pvt. Ltd.

### Reference Books

1. Alberts, B., A. Johnson, J. Lewis, *et al.*, 2015. *Molecular Biology of the Cell* (Sixth Edition), Garland Science, New York.
2. Lodish, H., C. A. Kaiser, A. Bretscher, *et al.*, 2013. *Molecular Cell Biology* (Seventh Edition), Macmillan, England.
3. Karp, G. 2010. *Cell Biology* (Sixth Edition), John Wiley & Sons, Singapore.
4. Tropp, B, 2008. *Molecular Biology Genes to Proteins* (Third Edition), Jones & Bartlett, US.
5. Abbas, A. K., A. H. Lichtman and S. Pillai, 2007. *Cell and Molecular Immunology* (Sixth Edition), Saunders, Philadelphia.

### Web Resources

1. <https://www.inspiritvr.com/general-bio/cell-biology/passive-and-active-transport-study-guide>
2. <https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article>
3. <https://www.khanacademy.org/science/ap-biology/cell-communication-and-cell-cycle/changes-in-signal-transduction-pathways/a/intracellular-signal-transduction>
4. [https://bio.libretexts.org/Bookshelves/Cell\\_and\\_Molecular\\_Biology/Book%3A\\_CellsMolecules\\_and\\_Mechanisms\\_\(Wong\)/11%3A\\_Protein\\_Modification\\_and\\_Trafficking/11.02%3A\\_Protein\\_Trafficking](https://bio.libretexts.org/Bookshelves/Cell_and_Molecular_Biology/Book%3A_CellsMolecules_and_Mechanisms_(Wong)/11%3A_Protein_Modification_and_Trafficking/11.02%3A_Protein_Trafficking)
5. <https://openoregon.pressbooks.pub/mhccmajorsbio/chapter/control-of-the-cell-cycle/>

**MAPPING WITH PROGRAMME OUTCOMES  
PROGRAMME SPECIFIC OUTCOMES**

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
<b>CO1</b>	3	3	3	3	3	3	3	3	2	3	3	3
<b>CO2</b>	3	3	1	2	2	2	2	3	1	2	2	1
<b>CO3</b>	3	3	3	3	3	3	2	2	3	2	3	2
<b>CO4</b>	3	3	1	2	2	2	2	2	3	2	3	2
<b>CO5</b>	2	3	3	3	3	3	3	2	3	3	2	3
<b>TOTAL</b>	14	15	11	13	13	13	12	12	12	12	13	11
<b>AVERAGE</b>	2.8	3.0	2.2	2.6	2.6	2.6	2.4	2.4	2.4	2.4	2.6	2.2

**3-Strong, 2- Medium, 1- Low**

**SEMESTER II  
CORE COURSE IV: DEVELOPMENTAL BIOLOGY**

Course Code	L	T	P	S	Credits	Inst. Hours	Total hrs	Marks		
								CIA	External	Total
ZP232CC2	4	1	-	1	5	6	90	25	75	100

**Pre-requisite**

A basic understanding of biology and genetics is recommended to effectively grasp the concepts in developmental biology.

**Learning Objectives**

1. Understand the principles of developmental biology to analyze and compare the embryonic development of different animal species.
2. Study the concepts, procedures, and uses of genes and hormones to propose strategies to improve and control the development of certain animal species.

**Course Outcome**

<b>On the successful completion of the course, student will be able to:</b>		
<b>CO - 1</b>	recall and summarize the chief events in animal development, recognizing their significance and historical context	<b>K1</b>
<b>CO - 2</b>	understand the different mechanisms and how extrinsic and intrinsic factors influence embryonic development in various animal embryos.	<b>K2</b>
<b>CO - 3</b>	apply their knowledge to explain the role of hormones in animal development.	<b>K3</b>
<b>CO - 4</b>	analyze the different stages of embryonic development and the genetic	<b>K4</b>

	control mechanisms involved.	
<b>CO - 5</b>	critically evaluate ethical issues associated with cryopreservation in mammalian reproduction.	<b>K5</b>
<b>CO - 6</b>	design and propose experiments related to biochemical changes during regeneration or cryopreservation techniques.	<b>K6</b>

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

<b>Units</b>	<b>Contents</b>	<b>No. of Hours</b>
I	Pattern of animal development: Chief events in animal development. Gametogenesis: Origin of germ cells, spermatogenesis - sperm morphology in relation to the type of fertilization, oogenesis - oogenesis in insects and amphibians; composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates; Genetic control of vitellogenin synthesis in amphibians.	18
II	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.	18
III	Cleavage and gastrulation:Pattern of embryonic cleavage, mechanisms of cleavage – Gastrulation - morphogenic movements - gastrulation in respective animal embryos (Sea urchin, Amphibians, Mammals); Fate maps - (Amphibian and Chick), Epigenesis and preformation – Formation of primary germ layers	18
IV	Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammal –Formation and migration of neural crest cells - types of neural crest cells - primary and secondary neurulation. Organogenesis (mammal): Development of ectodermal derivatives (nervous system). endodermal (digestive system), mesodermal (circulator system). 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	18
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: Types of regeneration, Regeneration in planaria and frog - Regenerative ability in different animal groups. Factors stimulating regeneration. – Aging and senescence: Biology of senescence- cause of aging- mechanism involved inapoptosis. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Endocrine changes associated with normal pregnancy, Induced ovulation in humans – Cryopreservation of gametes/embryos - Ethical issues in cryopreservation	18

<b>Self-study</b>	Spermatogenesis, Oogenesis in amphibians, parthenogenesis, Fate maps, Regenerative ability in different animal groups..
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### Textbooks

1. Gilbert. S. F. 2006. *Developmental Biology*, 8th Edition, INC Publishers, USA
2. Balinsky, B. I. 1981. *Introduction to Embryology*. (5th Edition), CBS College Publishers, New York.

### Reference books

1. Tyler, M.S, 2000. *Developmental Biology - A Guide for Experimental Study*, Sunderland, MA.
2. Subramoniam, T, 2011. *Molecular Developmental Biology* (2nd Edition), Narosa Publishers, India.
3. Slack J.M.W, 2012. *Essential Developmental Biology* (3rd Edition), Wily-Blackwell Publications, USA.
4. Mari-Beffa, M. and J. Knight, 2005. *Key Experiments in Practical Developmental Biology*, Cambridge University Press, UK.
5. Lewis Wolpert, Cheryll Tickle, Alfonso Martinez Arias, 2019. *Principles of Development*. Sixth Edition. Oxford University Press, USA.

### Web resources

1. <https://www.easybiologyclass.com/tag/developmental-biology/>
2. [www.studocu.com](http://www.studocu.com) > document > lecture-notes > view
3. [ocw.mit.edu](http://ocw.mit.edu) > courses > 7-22-development-mental-biology-f.
4. <https://learninglink.oup.com/access/barresi-12e>
5. <https://www.khanacademy.org/science/biology/developmental-biology>

### MAPPING WITH PROGRAMME OUTCOMES PROGRAMME SPECIFIC OUTCOMES

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PO 7
CO1	3	2	1	3	2	3	3	3	2	3	2	2
CO2	3	1	1	3	2	3	3	3	2	2	3	2
CO3	3	2	1	2	2	2	2	2	3	2	2	2
CO4	3	1	1	3	1	3	3	3	3	3	3	2
CO5	3	2	1	2	3	3	2	3	2	2	2	2
<b>Total</b>	15	8	5	13	10	14	13	14	12	12	12	10
<b>Average</b>	3	1.6	1	2.6	2	2.8	2.6	2.8	2.4	2.4	2.4	2

3 - Strong; 2 - Medium; 1 - Low

### SEMESTER II CORE LAB COURSE II: LAB COURSE IN CELL BIOLOGY AND DEVELOPMENTAL BIOLOGY

Course Code	L	T	P	S	Credits	Inst.	Total	Marks
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						Hours	hrs	CIA	External	Total
ZP232CP1	-	-	4	-	2	4	60	25	75	100

### Pre-requisite

Students should have acquired basic knowledge relevant to this lab course.

### Learning Objectives

1. To demonstrate significant cellular, molecular biological principles into practical understanding.
2. To gain theoretical knowledge and hands-on skills in developmental biology.

### Course Outcomes

1.	recall the principles of using a micrometer for cell size determination and the stages of mitosis & meiosis and their characteristics.	K1
2.	comprehend the steps involved in preparing blood smears and mounting the muscle fibres using microscopy.	K2
3.	develop handling - skills through the wet-lab course.	K3
4.	interpret observations & make connections between reproductive processes and the ecological context of the organisms studied	K4
5.	evaluate and compare different developmental stages in chick embryos.	K5

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

### Cell and Molecular Biology

1. Determination of cell size using micrometer.
2. Identification of Mitotic stages in onion root tips.
3. Identification of various stages of meiosis in the testes of grasshopper.
4. Observation of polytene chromosome in salivary gland cells of Chironomus larva.
5. Detection of sex chromatin in squamous epithelium.
6. Identification of blood cells in the haemolymph of the cockroach.
7. Identification of blood cells in human blood.
8. Mounting of the coxal striated muscle fibers of cockroach.
9. Observation of adipocytes - fat body of cockroach.
10. Isolation of total RNA from bacterial cells/ tissues. (Demonstration)

**Spotters:** Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer.

**Spotters:** Fluid mosaic model, Golgi complex, Cancer cell, Cadherins, Karyotype, Haemocytometer.

### Developmental Biology

#### Gametogenesis - Observation of gametes from gonadal tissue sections

1. **Oogenesis:** Section through ovary of shrimp, fish, frog and mammals
2. **Spermatogenesis:** Section through testis of shrimp, fish, calottes and mammals.
3. **Fertilization:** Induced spawning in fish.
4. **Embryogenesis:** Observation and whole mount preparation of the

- i. Chick blastoderm - 18 hours of development
- ii. Chick embryonic stage - 24 hours of development
- iii. Chick embryonic stage - 48 hours of development
- iv. Chick embryonic stage - 72 hours of development
- v. Chick embryonic stage - 96 hours of development

5. **Histological observation:** Section through various developmental stages in chick embryo
6. **Experimental Embryology:** Regeneration in Frog Tadpoles - Blastema formation.
7. **Metamorphosis:** Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine
8. **Cryopreservation:** Demonstration of cryopreservation of gametes of fin fish/shell fish

**Reference books:**

1. Renu Gupta, SeemaMakhija, Dr. Ravi Toteja, 2018. *Cell Biology : Practical Manual*. Prestige Publishers, India.
2. MamtaVerma, 2023. *Practical Book Cell Biology &Cytogenetics Lab*. Krishna Prakashan Media (P) Ltd., India.
3. Wilt, F.H. and N.K. Wessel, 1967. *Methods in Developmental Biology*, Thomas Y Crowell, New York.
4. Slack J.M.W, 2012. *Essential Developmental Biology* (3<sup>rd</sup> Edition), Wily-Blackwell Publications, USA, pp-496.
5. Mari-Beffa, M. and J. Knight, 2005. *Key Experiments in Practical Developmental Biology*, Cambridge University Press, UK, pp-404.

**MAPPING WITH PROGRAMME OUTCOMES**  
**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	1	3	2	3	2	3	3	2	3	2
CO2	3	1	1	3	2	3	2	3	3	2	2	3
CO3	3	2	1	2	2	2	2	2	2	3	2	2
CO4	3	1	1	3	1	3	2	3	3	3	3	3
CO5	3	2	1	2	3	3	2	2	3	2	2	2
<b>Total</b>	15	8	5	13	10	14	10	13	14	12	12	12
<b>Average</b>	3	1.6	1	2.6	2	2.8	2	2.6	2.8	2.4	2.4	2.4

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

**SEMESTER II**

**ELECTIVE COURSE III: a) ECONOMIC ENTOMOLOGY**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
ZP232EC1	2	1		1	3	4	60	25	75	100

**Pre-requisite**

Basic background in biological sciences with a special emphasis on the study of insects.

## Learning Objectives

1. Develop the ability to identify and classify insects into major orders and understand their economic importance.
2. Acquire practical skills in observing and documenting the life cycles and behaviors of beneficial and destructive insects.

## Course Outcomes

On the successful completion of the course, students will be able to:		
1.	recall the features of various insect orders and describe the life history, social organization, and management practices of insects.	<b>K1</b>
2.	understand the biology of insects associated with medical, household, and veterinary/public health importance.	<b>K2</b>
3.	apply their knowledge of pest biology to assess damage and beneficial insect life cycles to practical rearing.	<b>K3</b>
4.	analyze the causes of pest outbreaks and the economic threshold levels.	<b>K4</b>
5.	synthesize knowledge to propose effective control measures for vectors associated with medical, household, and veterinary/public health importance.	<b>K5</b>

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

Unit	Contents	No. of hours
I	Overview of insects and insect taxonomy: Insects and their biological success - Man and insects; Salient features of Class Insecta and orders - Orthoptera, Isoptera, Hemiptera, Diptera, Coleoptera, Lepidoptera, Dermaptera, Odonata, Neuroptera and Hymenoptera. Basic concepts in Insect Taxonomy and classification.	12
II	Beneficial insects: Silkworms - types, life cycle of <i>Bombyxmori</i> , diseases and its 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.	12
III	Destructive insects: Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Biology of the insect pests - Pests of paddy, cotton, sugarcane, vegetables, coconut and stored grains cereals.	12
IV	Pest management/Control strategies: Methods and principles of pest control - Natural control, Artificial control, Merits and demerits or limitations of these methods in pest control - Development and uses of pest resistant plant varieties - Integrated pest management - Concepts and practice.	12
V	Vector biology: Stable fly and cattle fly; Fowl - shaft louse and chicken flea; sheep and goat - head maggot and sheep ked. Insects associated with medical importance and management - head louse <i>Pediculushumanuscapitis</i> , mosquitoes - <i>Anopheles</i> , <i>Culex</i> , <i>Aedes</i> , flea -	12



<i>Xenopsyllacheopsis</i> , eye fly, sand fly, ticks, mites and bed bug. <b>Insects associated with household insects - cockroaches, termites and silverfish. Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control measures.</b>
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<b>Self-study</b>	Types of honey bees, Pest of Paddy, Natural control of pest.
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### Textbooks

1. Ayyar, L.V. R, 1936. Hand book of Economic Entomology for South India. Narendra Publishing House. New Delhi.
2. Vasantharaj David, B. and V.V. Ramamurthy, 2016. Elements of Economic Entomology, Eighth Edition, Brillion Publishing, New York.
3. Ross. H.H. 195. A Text Book of Entomology, John Wiley & Sons Inc., New York.

### Reference Books

1. Chapman, R.F., S.J. Simpson and A.E. Douglas, 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, Lodo.
2. Daly, H.V., J.T. Doyen and P.R. Ehrlich, 1978. Introduction to Insect Biology and Diversity. McGraw-Hill Kogakusha Ltd., Tokyo.
3. Hill, D.S, 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York.
4. Krishnaswami. S, 1973. Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
5. Mani, M.S, 1982. General Entomology. Oxford & IBH Publishing Co., India.

### Web Resources

1. <https://egyankosh.ac.in/bitstream/123456789/85342/1/Unit-4.pdf>
2. [https://www.rlbcu.ac.in/pdf/PGCourse/Entomology/Insect%20Taxonomy%20\(APE%2003\).pdf](https://www.rlbcu.ac.in/pdf/PGCourse/Entomology/Insect%20Taxonomy%20(APE%2003).pdf)
3. <https://egov.uok.edu.in/elearning/tutorials/1011020512BR15103CR15Apiculture%20Lac%20culture%20and%20sericultureapiculture%20lac%20culture%20and%20sericulture%20upload.pdf>
4. [https://agritech.tnau.ac.in/farm\\_enterprises/fe\\_api\\_pestanddiseases.html](https://agritech.tnau.ac.in/farm_enterprises/fe_api_pestanddiseases.html)
5. [https://cpacollege.ac.in/assets/uploads/1645091697APPLIED\\_ZOOLOGY\\_SEM\\_NOTE\\_.pdf](https://cpacollege.ac.in/assets/uploads/1645091697APPLIED_ZOOLOGY_SEM_NOTE_.pdf)

### MAPPING WITH PROGRAMME OUTCOMES

#### MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2	3	2	3	2	3	3	3
CO2	3	2	3	3	2	3	2	3	3	2	2	3
CO3	2	2	3	3	2	2	2	2	2	3	2	2
CO4	2	2	3	3	2	2	2	2	3	3	3	3

<b>CO5</b>	2	2	3	3	2	2	2	2	2	2	3	3
<b>Total</b>	12	10	15	13	14	12	10	12	12	13	13	14
<b>Average</b>	2.4	2	3	2.6	2.8	2.4	2	2.4	2.4	2.6	2.6	2.8

3 - Strong; 2 - Medium; 1-Low

**SEMESTER II**  
**ELECTIVE COURSE III: b) PARASITOLOGY**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hrs.	Marks		
								CIA	External	Total
ZP232EC2	2	1	-	1	3	4	60	25	75	100

**Pre-requisite:**

The students with a basic background in biological sciences with a special emphasis on the study of parasites.

**Course Objectives:**

1. To enable the students to be aware of the cosmopolitan distribution of parasites.
2. Develop skills for employment in clinical laboratories and health departments.

**Course Outcomes**

On the successful completion of the course, student will be able to:		
1.	define the basic biology and life cycle of parasites including epidemiology, diagnosis, and treatment.	<b>K1</b>
2.	explain morphological characters of parasites, developmental stages and their infestation.	<b>K2</b>
3.	identify appropriate techniques and develop basic skills for detection of parasites.	<b>K3</b>
4.	analyse the medical and public health aspects of human parasitic infections.	<b>K4</b>
5.	compare the diagnostic methods of parasitic infestation in veterinary hospitals, clinics and research laboratories.	<b>K5</b>

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

Unit	Contents	No. of hours
I	Taxonomy and classification of parasites - origin and evolution of parasitism - host parasite relationship, classification of parasites and hosts - transmission of parasites - Parasitic zoonoses- pathogenesis - clinical manifestations of parasitic diseases.	12
II	Protozoan parasites: Introduction and classification. Intestinal Amoeba - Pathogenic free-living amoeba - Intestinal flagellates - Trypanosomiasis, Leishmaniasis, Balantoidiasis, Malaria,	12

	Isosporiasis, <i>Toxoplasmosis, Cryptosporidiosis, Pneumocystis</i> . Protozoans of minor medical importance.	
III	Helminth parasites: <i>Trichuriasis, Trichinellosis, Strongyloidiasis, Ascariasis, Enterobiasis, Filariasis, hookworm diseases, Dracunculiasis, Onchocerciasis, Loiasis, Larva migrants.</i> Nematodes of lesser medical importance - <i>Diphyllobothriasis, Taeniasis, Echinococcosis, Sparganosis, Schistosomiasis, Fascioliasis, Fasciolopsiasis, Paragonimiasis, Clonorchiasis, Trematodes</i> of minor medical importance.	12
IV	<b>Parasitic Insects:</b> Prevalence, transmission, and control of parasitic infections. Parasitic infection in a compromised host. Applied Parasitology - Eosinophilia in parasitic infections, Nosocomial parasitic infections. Evasion and parasitic mode of life - morphological, biochemical, and ethological adaptations. Quality assurance and laboratory safety.	12
V	<b>Diagnostic methods in parasitology:</b> General rules for microscopical examination. Microscopical examination of blood, stool, urine, sputum and biopsy material for parasites. Cultural examination - preparation of media - techniques for cultivation of <i>E. histolytica</i> , Leishmania, Plasmodium. <i>Immunodiagnostic methods - IFA, AGD, IHA, IFAT, CFT, DAT, BF, DFAT.</i> Molecular characterization of stage specific antigen nucleotide probes for diagnosis of protozoan diseases.	12

<b>Self-study</b>	host parasite relationship, Intestinal Amoeba, Quality assurance and laboratory safety, General rules for microscopical examination
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### Textbooks

1. Jayaram Paniker C. K. & Sougata Ghosh, 2013. Paniker's Textbook of Medical Parasitology. Jaypee Brothers Medical Publishers, Maharashtra, India.
2. Rajesh Karyakarte & Ajit Damle, 2008. *Medical Parasitology* (2<sup>nd</sup> ed.). Books and Allied (P) Ltd., Kolkata.

### Reference Books

1. Ichhpujani R.L. & Rajesh Bhatia, 2002. *Medical Parasitology*. Jaypee printers. New Delhi
2. Patvaik, B.D, 2001. *Parasitic Insects*. Delhi: Dominant Publishers and Distributors.
3. Jones, A.W, 1976. *Introduction to Parasitology*.: Addison -Wesley Publishing Company. Boston, USA
4. Subah, C.P, 2001. *Textbook of Medical Parasitology*: All Publishers and Distributors. Chennai.
5. Elizabeth Zeibig, 2012. *Clinical Parasitology: A Practical Approach*. 2nd Edition. Saunders, United States.

### Web Resources

1. [https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture\\_notes/health\\_scie](https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/health_scie)

nce\_students/medicalparasitology.pdf

- https://www.amboss.com/us/knowledge/general-parasitology/
- https://www.jaypeedigital.com/eReader/chapter/9789352704804/ch1
- https://www.physio-pedia.com/Parasitic\_Infections
- https://www.mdpi.com/2414-6366/7/10/253

**MAPPING WITH PROGRAMME OUTCOMES**  
**MAPPING WITH PROGRAMME SPECIFIC OUTCOMES**

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	2	3	3	2	3	2	3	2	3	3	3
CO2	3	2	3	3	2	3	2	3	3	2	2	3
CO3	2	2	3	3	2	2	2	2	2	3	2	2
CO4	2	2	3	3	2	2	2	2	3	3	3	3
CO5	2	2	3	3	2	2	2	2	2	2	3	3
<b>Total</b>	12	10	15	13	14	12	10	12	12	13	13	14
<b>Average</b>	2.4	2	3	2.6	2.8	2.4	2	2.4	2.4	2.6	2.6	2.8

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

**SEMESTER II**  
**ELECTIVE COURSE III: c) AGROCHEMICALS AND**  
**PEST MANAGEMENT**

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hrs.	Marks		
								CIA	External	Total
ZP232EC3	2	1		1	3	4	60	25	75	100

**Pre-requisite**

The students with a basic background in biological sciences with a special emphasis on the study of fertilizers and insects' pests.

**Learning Objectives**

- To enable the students to be aware of the various types of biological pesticides and their uses.
- Able to control pest and about their selective mode of action. It also gives an account of eco-friendly biological pesticides.

**Course Outcomes**

<b>On the successful completion of the course, student will be able to:</b>		
1.	outline agrochemicals, their modes of action and their fate in the agro-ecosystem.	<b>K1</b>

2.	recognize pesticide families based on their specific modes of activity.	<b>K2</b>
3.	apply appropriate pesticide management strategies by evaluating specific pest type.	<b>K3</b>
4.	analyze the impact of agrochemicals and pesticides for effective pest management.	<b>K4</b>
5.	evaluate the efficacy of organic manures, chemical fertilizers, conventional pesticides and bio-pesticides for agronomical practices.	<b>K5</b>

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

Unit	Contents	No. of hours
I	Definition, classification, morphology, and internal systems; Plant pests – weeds, bacteria, fungi, Viruses, nematodes, molluscs, Arthropods, birds, mammals etc.; Causes of outbreak of pest, growth and development; Classification based on nature of damage: Public health pests, Agricultural pests, Domestic pests, Animal husbandry pests, Structural pests.	12
II	Manures: types, composition and value, sources of manures, Compost-Different composting technologies-Mechanical compost. plants-Vermicomposting- Green Manures - Oil cakes, Sewage Sludge-Biogas plant slurry.	12
III	Chemical fertilizers: Classification and value. N- fertilizers: Manufacturing of Ammonium Sulphate, Ammonium Chloride, Ammonium Nitrate and urea; P- fertilizers: sources, processing rock phosphate, bones for bone meal preparation; K- fertilizers: sources, Potassium Chloride, Potassium Sulphate and Potassium Nitrate; Biofertilizers: Classification and value; viz., <i>Rhizobium</i> , <i>Azotobacters</i> , <i>Azolla</i> , Blue Green Algae, VAM	12
IV	Conventional chemicals/ pesticides based on target species: Acaricides, Fungicides, Rodenticides, Nematicides, Molluscicides, Fumigants and Repellents; Based on chemical nature: Organophosphates; Organochlorines, Carbamates etc.; Structure, chemical name, physical and chemical properties; Mode of action, uses, toxicity; Application of Pesticides, devices used; dose estimation for field application.	12
V	Potential pesticidal plants; Plant extracts and Bio-organisms: Azadirachtin and its role in pest control; Other biopesticides: Pyrethrins, Pyrethroids, Rotenone, Nicotine and Nicotinoids. Growth inhibitors or physiological antagonists, chemo-sterilant; pheromones and attractants; Insect growth regulators, juvenile hormones, moulting hormones; BT methodology, genetically	12

	modified and transgenic plants	
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### Textbooks

1. Sathe, T. V. 2008. *Agrochemicals and Pest Management*. Daya Publishing House, New Delhi.
2. Patil, T. V. Sathe. 2003. *Insect Predators and Pest Management*. Daya Publishing House,

<b>Self-study</b>	Types of manure, Biofertilizer: <i>Rhizobium</i> , <i>Azotobacters</i> , <i>Azolla</i> , Blue Green Algae,
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New Delhi.

### Reference books

1. Dent, D, 2000. *Insect pest management*. 2nd edition. CAB International. E-pdf.
2. Roberts, D.A, 1978. *Fundamentals of Plant Pest Control*. First Edition. W. H. Freeman.
3. Koul, O. and Dhaliwal, G.S, 2003. *Phytochemical Biopesticides*, Harwood Academic Publishers, Amsterdam.
4. Pedigo, L.P, 1996. *Entomology and pest management*, Prentice Hall, N. Delhi.

### Web Resources

1. <https://ugcmoocs.inflibnet.ac.in/assets/uploads/1/165/5582/et/35%20script200306101003033939.pdf>
2. <https://byjus.com/biology/effects-of-agrochemicals/>
3. <https://www.vedantu.com/biology/agrochemicals>
4. <https://www.gov.nl.ca/ecc/files/env-protection-pesticides-business-manuals-applic-chapter7.pdf>
5. <https://courseware.cutm.ac.in/wp-content/uploads/2020/06/Lecture-Notes-IPDM.pdf>

### MAPPING WITH MAPPING WITH PROGRAMME OUTCOMES MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
CO1	3	2	3	3	2	2	3	3	2	3	3	3
CO2	3	2	3	3	2	2	2	3	3	2	2	3
CO3	3	2	3	3	2	2	2	2	2	3	2	2
CO4	3	2	3	3	2	2	2	2	3	3	3	3
CO5	3	2	3	3	2	2	2	2	2	2	3	3
<b>Total</b>	15	10	15	15	10	10	10	12	12	13	13	14
<b>Average</b>	3	2	3	3	2	2	2	2.4	2.4	2.6	2.6	2.8

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

**SEMESTER II**  
**ELECTIVE COURSE IV: a) RESEARCH METHODOLOGY**

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZP232EC4	2	1		1	3	4	60	25	75	100

**Pre-requisite**

Students should have a good understanding of the fundamental methods used in experimental biology.

**Learning Objectives**

1. To impart knowledge on the basic principle, methodologies and applications of instruments in biological sciences.
2. Develop essential research skills to operate and apply various biological science instruments.

**Course Outcomes**

On the successful completion of the course, students will be able to:		
1.	recall the principles of laboratory equipments, research techniques and the process of scientific report writing.	<b>K1</b>
2.	Explain the procedures involved in operating laboratory equipment, applying research techniques, and engaging in scientific writing.	<b>K2</b>
3.	apply biological techniques in laboratory settings to gain practical experience in research processes and scientific report writing.	<b>K3</b>
4.	analyze the principles and techniques to make wise choices in experimental design, data interpretation, and research reports in biological sciences.	<b>K4</b>
5	evaluate the quality, reliability, and limitations of data generated by research techniques and obtained from literature for specific research goals.	<b>K5</b>

**K1** - Remember; **K2** - Understand; **K3** – Apply; **K4** – Analyse; **K5** - Evaluate

Units	Contents	No. of hours
I	Analytical Techniques: Good laboratory practice (GLP), pH meter, Colorimeter, Spectrophotometer - UV-Visible, Atomic Absorption, Flame photometer, FTIR spectrometry.	12
II	Microscopy & Micro technique: Principle, Working mechanism and applications of Bright field, Phase contrast, Electron, Confocal Microscope and Atomic force microscope. Histology – Fixation, Sectioning and Staining. Histochemistry for carbohydrates, proteins, lipids.	12

III	Separation Techniques: Centrifugation – Differential and Density gradient, types and applications of Centrifuges. Chromatography - Principle, HPLC and Affinity chromatography, GAS Chromatography Mass Spectrometry. Electrophoresis - Principle, Agarose gel electrophoresis and PAGE.	12
IV	Tracer techniques: Radioactive isotopes, Radiolabeling, Radiocarbon dating, Radioactivity counters - Scintillation Counter, Geiger Muller Counter.	12
V	Scientific Writing: Essential steps in research, Review of literature, Literature citation, Research report – Abstract, Tables - Figures - Formatting and typing, Open access journals, Predatory journals, Impact factor, Citation index, H-index, Plagiarism, CopyRight.	12

<b>Self-study</b>	Principle, Working mechanism and applications of Electron and Phase contrast Microscope, Centrifugation - Principle, types and applications of Centrifuges, Bioinstrumentation of pH meter, Colorimeter, and UV-Visible Spectrophotometer, Quantification of carbohydrate, protein, lipid, Essential steps in research.
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#### Textbooks

1. Veerakumari. L, 2006.*Bioinstrumentation*.MJP Publishers.Triplicane, Chennai.
2. Gurumani. N, 2006.*Research Methodology for Biological Sciences*.MJP Publishers.Triplicane, Chennai

#### Reference Books

1. Marimuthu. R, 2008.*Microscopy and Microtechnique*.MJP Publishers.Chennai.
2. Keith Wilson and John Walker, 2018. *Principles and Techniques of Practical Biochemistry* (8<sup>th</sup> ed.). Cambridge University Press. India.
3. Pranav Kumar, 2018. *Fundamentals and Techniques of Biophysics and Molecular Biology*.Pathfinder publication. India.
4. Paneerselvam R, 2016. *Research Methodology*.PHI Learning Pvt. Ltd. India.
5. Gurumani N, 2010.*Scientific thesis writing and paper presentation*. MJP Publishers. Chennai

#### Web Resources

1. <https://en.wikipedia.org/wiki/Microtechnique>
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5206469/>
3. <https://www.vedantu.com/physics/spectroscopy>
4. [https://en.wikipedia.org/wiki/Blot\\_\(biology\)](https://en.wikipedia.org/wiki/Blot_(biology))
5. [https://en.wikipedia.org/wiki/List\\_of\\_research\\_methods\\_in\\_biology](https://en.wikipedia.org/wiki/List_of_research_methods_in_biology)

### MAPPING WITH PROGRAMME OUTCOMES MAPPING WITH PROGRAMME SPECIFIC OUTCOMES

Cos	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
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<b>CO1</b>	3	2	1	3	2	3	2	3	3	2	3	2
<b>CO2</b>	3	1	1	3	2	3	2	3	3	2	2	3
<b>CO3</b>	3	2	1	2	2	2	2	2	2	3	2	2
<b>CO4</b>	3	1	1	3	1	3	2	3	3	3	3	3
<b>CO5</b>	3	2	1	2	3	3	2	2	3	2	2	2
<b>Total</b>	15	8	5	13	10	14	10	13	14	12	12	12
<b>Average</b>	3	1.6	1	2.6	2	2.8	2	2.6	2.8	2.4	2.4	2.4

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

## SEMESTER II

### ELECTIVE COURSE IV: b) APICULTURE

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
<b>ZP232EC5</b>	<b>3</b>	<b>1</b>	<b>-</b>	<b>-</b>	<b>3</b>	<b>4</b>	<b>60</b>	<b>25</b>	<b>75</b>	<b>100</b>

#### Pre-requisite

Students should be aware of importance of honey bees and their impacts on the ecosystem.

#### Learning Objectives

1. Impart knowledge on the morphology, life cycle, characteristics of honey bees and bee keeping.
2. Acquired skills to perform bee keeping from managing colonies of bees to harvest honey and other bee related by-products in different setups and as an Entrepreneurial venture.

#### Course Outcomes

<b>On the successful completion of the course, students will be able to:</b>		
1.	understand the morphology, life cycle, characteristics of honey bees and bee keeping.	<b>K1</b>
2.	acquire skills to perform bee keeping from managing colonies of bees in order to harvest honey and other Bee related by-products in different setups and as an Entrepreneurial venture.	<b>K2</b>
3.	knowledge on the harvesting, preserving and processing of bee products and identification of the appropriate markets to sell the produce.	<b>K3</b>
4.	identify of different bee enemies and diseases and control measures and its management	<b>K4</b>
5.	evaluate the honey chemical composition of different environment.	<b>K5</b>

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

Units	Contents	No. of Hours
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I	Introduction to Apiculture. Scope and importance. History, classification, types of honey bees - morphology, mouth parts and sting of Honey bees – life cycle of different species and their behavioural patterns. Social organization of bee colony. morphology, mouth parts and sting of Honey bees –	12
II	Bee-keeping system, tools and equipment's needed for bee keeping. Types of bee hives, structure, and functional features. Criteria for site selection for apiculture and factors affecting them. Flora for apiculture – selection of Bees for apiculture, Method of bee keeping.	12
III	Identification and Preventive measures to be taken against pests (The Greater wax moth & Wasps and Hornets) and parasites (tracheal mite). Diseases (Nosema disease, Sac-brood disease, European foulbrood disease), and their control measures. Colony collapse disorder and its management.	12
IV	Bee products, uses and importance- Honey, Royal jelly, Propolis, Pollen and Bee venom. Harvesting, Processing, Packaging and Marketing of bee products.	12
V	Apiculture industry around the world and Role of Central Bee Research & Training institute in India. Apiculture as an Entrepreneurial venture.	12

<b>Self-study</b>	Introduction to Apiculture. History, classification, types, life Cycle, Tools and equipment's needed for bee keeping, Diseases affecting honey bees and their control measures. Bee products, uses and importance- Honey, Royal jelly, Propolis, Pollen and Bee venom.
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#### **Text book**

1. Singh, D., Singh, D. Pratap. 2006. *A Handbook of Beekeeping*. Agrobios, India.
2. Mishra R.C. 2002. *Perspectives in Indian Apiculture*, Agrobios, India.

#### **Reference Books**

1. Dharam P. Abrol, 2019. *Beekeeping: A compressive guide to bees and beekeeping*. Scientific Publishers. Jodhpur, India.
2. Caron, D.W, 2013 (revised from 1999). *Honey Bee Biology and Beekeeping*. Wicwas Press. United States.
3. Dewey M. Caron, Lawrence John Connor, 2013. *Honey Bee Biology and Beekeeping*, Revised Hardcover. Wicwas Press. United States.
4. Ross Conrad, Gary Paul Nabhan, 2007. *Natural Beekeeping: Organic Approaches to Modern Apiculture*. Chelsea Green Publishing. United States.
5. Alphonse Avitabile, Jan Propst, 1998. *The Beekeeper's Handbook*. Comstock Pub. Associates. Cornell University Press.

#### **Web Resources**

1. <https://www.britannica.com/topic/beekeeping>
2. <https://nbb.gov.in/pdf/Pests&DiseasesHoneybees&Management.pdf>
3. <https://www.aakash.ac.in/important-concepts/biology/apiculture-in-indian>
4. <https://vikaspedia.in/agriculture/farm-based-enterprises/bee-keeping-1/about-bee-keeping>
5. <https://beebuilt.com/pages/beekeeping-for-beginners>

**MAPPING WITH PROGRAMME OUTCOMES  
PROGRAMME SPECIFIC OUTCOMES**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5
<b>CO1</b>	2	1	2	2	2	3	3	2	2	3	2	2
<b>CO2</b>	3	1	2	2	1	3	2	2	2	3	2	2
<b>CO3</b>	3	2	2	2	2	2	1	2	2	3	2	2
<b>CO4</b>	2	3	3	2	2	3	3	2	3	3	2	2
<b>CO5</b>	3	2	3	2	3	2	3	2	3	3	2	2
<b>TOTAL</b>	13	9	12	10	10	13	12	10	12	15	10	10
<b>AVERAGE</b>	2.6	1.8	2.4	2	2	2.6	2.4	2	2.4	3	2	2

**3 – Strong, 2- Medium, 1- Low**

**SEMESTER II**

**ELECTIVE COURSE – IV: c) SERICULTURE**

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
<b>ZP232EC6</b>	<b>2</b>	<b>1</b>		<b>1</b>	<b>3</b>	<b>4</b>	<b>60</b>	<b>25</b>	<b>75</b>	<b>100</b>

**Pre-requisite:**

Students should have a fundamental knowledge of biology, an entrepreneurial mindset, and an appreciation for the economic and cultural significance of sericulture.

**Learning Objectives:**

1. To gain in-depth knowledge of silk fiber types, sources, properties, and the significance of sericulture in India.
2. To develop practical skills in moriculture, silkworm rearing, and cocoon processing.

**Course Outcomes**

<b>On the successful completion of the course, students will be able to:</b>		
<b>1.</b>	recall and describe the fundamental concepts, terminology, and processes related to sericulture, and sericulture industry practices.	<b>K1</b>
<b>2.</b>	demonstrate the key concepts, processes, properties of silk fiber, mulberry cultivation techniques, cocoon characteristics, and the significance of sericulture practices in the silk production industry.	<b>K2</b>

3.	apply their knowledge of sericulture principles and practices to solve practical problems and optimizing cocoon processing techniques.	<b>K3</b>
4.	critically analyze the challenges and opportunities in the sericulture industry and assess the economic and environmental implications of sericulture practices.	<b>K4</b>
5.	evaluate the effectiveness of different sericulture practices, technologies, and policies, and make informed decisions to optimize silk production.	<b>K5</b>

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

Unit	Contents	No. of hours
I	Introduction to textile fibers; types - natural and synthetic fibers; sources of silk fiber - Tasar, Muga, Anaphe, Gonometa, Fagara, spider and mussel; properties and importance of silk fiber. History, development, status, characteristics, and advantages of sericulture in India.	12
II	Host plants; Moriculture - distribution, morphology, propagation- seedling, cutting, grafting, layering and micropropagation methods, maintenance-irrigation, manuring and pruning, pests and diseases of mulberry.	12
III	<i>Bombyx mori</i> - morphology, anatomy, life cycle, geographical locations, larval moults, voltinism, indigenous and commercial races. Diapause. Egg-storage and transportation.	12
IV	Rearing houses and equipment. Rearing operations- disinfection, brushing, feeding and spacing. Moulting and spinning. Harvest. Rearing methods- chawki, lasso, showa, shelf-rearing, floor-rearing and shoot rearing. Diseases of <i>Bombyx mori</i> - protozoan, bacterial, viral and fungal. Pests of silkworm- Uzi fly, dermestids, mites, ants, nematodes, aves and mammals.	12
V	Physical and commercial characteristics of cocoons. Cocoon harvesting and marketing. Cocoon sorting, stifling, deflossing, riddling, cooking, brushing, reeling and re-reeling. Weaving. By-products of sericulture industry.	12

<b>Self-study</b>	Sources of silk fiber - Tasar, Muga, Anaphe, Gonometa, Fagara, spider and mussel.
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### Textbooks

1. Ganga, G and J. SulochanaChetty, 2019. An Introduction to sericulture (2<sup>nd</sup>edn). Oxford and IBH Pub. Co. Pvt. Ltd., Delhi.

2. Johnson, M. and Kesary, M, 2019. Sericulture. Saras publications, Nagercoil.

### Reference Books

1. Food and Agriculture organization 1976. Manual on sericulture I, II & III. Delhi: Oxford and IBH Pub. Co. Pvt. Ltd., Delhi.
2. M.S. Jolly, 1987. Appropriate Sericulture Techniques. CSR & TI, Mysore
3. S.R. Ullal and M.N. Narasimhanna, 1987. Hand book of practical sericulture. CSB, Bangalore.
4. M.N. Narasimhanna, 1988. Manual on silkworm egg production. CSB, Bangalore.
5. Dandin, S.B., Jayaswal, J. and Giridhar. K, 2010. Handbook of sericulture technologies, Central Silk Board, Bangalore, India.

### Web Resources

1. <https://agritech.tnau.ac.in/sericulture/>
2. <https://csb.gov.in/>
3. <https://silks.csb.gov.in/>
4. <https://www.britannica.com/topic/sericulture>
5. [https://agritech.tnau.ac.in/sericulture/seri\\_index.html](https://agritech.tnau.ac.in/sericulture/seri_index.html)
6. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/sericulture>
7. <https://vikaspedia.in/agriculture/farm-based-enterprises/sericulture/sericulture-in-india>

### MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO1	PSO2	PSO3	PSO4	PSO5
CO 1	2	1	1	1	1	1	2	1	1	3	1	1
CO 2	2	2	1	1	1	1	2	1	1	3	1	1
CO 3	3	2	1	1	1	1	2	1	1	3	1	1
CO 4	3	3	1	1	1	1	2	1	1	3	1	1
CO 5	3	3	1	1	1	1	2	1	1	3	1	1
TOTAL	13	11	5	5	5	5	10	5	5	15	5	5
AVERAGE	2.6	2.2	1	1	1	1	2	1	1	3	1	1

**3 – Strong, 2 – Medium, 1 - Low**

### SEMESTER II ELECTIVE LAB COURSE -II: ECONOMIC ENTOMOLOGY & RESEARCH METHODOLOGY

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZP232EP1	2	1		1	3	2	30	25	75	100

### Pre-requisite:

Students should have knowledge relevant to economic entomology & research methodology.

### Learning Objectives:

1. To equip students with skills in both the practical aspects of economic entomology and the essential research methodology.
2. To acquire skills necessary for conducting meaningful studies in these field.

### Course Outcomes

On the successful completion of the course, students will be able to:		
1.	comprehend the principles and concepts of economic entomology & research methodology.	K1
2.	summarize the economic impact of insect pests. explain the principles behind different techniques & research designs	K2
3.	utilize appropriate methodologies to collect and analyze data of insects and apply statistical techniques to interpret and draw conclusions.	K3
4.	interpret practical solutions to address challenges in economic entomology, incorporating research methodology principles.	K4
5.	evaluate research methodologies and experimental designs used in economic entomology studies.	K5

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

### Economic Entomology

1. Collect and identify common insect pests in your local environment.
2. Dissection: Silk glands of silkworm.
3. Mounting: Mouth parts of honey bee. Mosquito.
4. Phototactic behavior of insect pests.
5. Collection and Identification of insect pests in the mulberry plants.

**Specimen/Spotters/Models:** Silkworm larva, pupa and adult, honey bee colony, Rhinoceros beetle, Red Palm Weevil, Banana Stem Weevil.

### Research Methodology

1. Whole mount preparation of two specimens.
2. Separation of amino acids using thin layer chromatography.
3. Sectioning and staining of a tissue.
4. Separation of pigments by column chromatography using plant extract (Demonstration).
5. Agarose Gel electrophoresis (Demonstration).

**Instruments/ Charts/ Models:** Phase contrast microscope, Fluorescent microscope, Spectrophotometer, HPLC, Flame photometer, Microtome, Electrophoretic apparatus.

### Textbooks

1. Bajia, R., R.N. Kencharaddi, B. Bairwa, K. Kumar, V. Kumar. *Practical handbook on fundamentals of entomology*. Second edition. Kalyani Publishers. Chennai.
2. Gurumani N, 2019. *Research Methodology: For Biological Sciences*. Kindle Edition. Chennai.

## Reference Books

1. Trigunayat, M.M, 2016. *A Manual of Practical Entomology*. 3rd Ed. Scientific Publishers. Jodhpur, Rajasthan.
2. Agrawal, N, 2022. *Fundamental Entomology: A Practical Manual*. Narendra Publishing House, New Delhi.
3. Ch Raja Goud, 2022. *Practical Manual on Fundamentals of Entomology*. Om Publishers. New Delhi
4. VinayakBairagi&MousamiVaibhavMunot, 2019. *Research Methodology: A Practical and Scientific Approach*. CRC press. Florida, United States.
5. Catherine Dawson, 2002. *Practical Research Methods: A User-Friendly Guide to Mastering Research Techniques and Projects*. Ubs Publishers' Distributors Pvt.Ltd.Ernakulam, Kerala.

## Web Resources

1. [https://www.researchgate.net/publication/327282644\\_A\\_Textbook\\_of\\_Economic\\_Entomology\\_M\\_Dayib](https://www.researchgate.net/publication/327282644_A_Textbook_of_Economic_Entomology_M_Dayib)
2. <https://academic-accelerator.com/encyclopedia/economic-entomology>
3. [https://books.google.co.in/books?id=z2s6nQAACAAJ&printsec=frontcover&source=gbs\\_ge\\_summary\\_r&cad=0#v=onepage&q&f=false](https://books.google.co.in/books?id=z2s6nQAACAAJ&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false)
4. <https://jru.edu.in/studentcorner/labmanual/agriculture/Insect%20morphology%20and%20systematics.pdf>
5. <https://www.scribbr.com/dissertation/methodology/>

## MAPPING WITH PROGRAMME OUTCOMES AND PROGRAMME SPECIFIC OUTCOMES

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PS O1	PSO2	PSO3	PSO4	PSO5
CO 1	1	1	1	1	1	1	2	1	1	2	1	1
CO 2	1	1	1	1	1	1	2	1	1	2	2	1
CO 3	2	1	1	1	2	1	2	1	1	3	2	2
CO 4	3	2	2	2	1	3	2	1	1	3	1	3
CO 5	3	2	2	3	3	1	2	1	2	3	3	3
TOTAL	10	7	7	8	5	7	10	5	6	13	9	10
AVERAGE	2.6	2.2	2.2	2.4	1.4	2.2	2	1.4	1.6	2.4	1.8	2.6

3 – Strong, 2 – Medium, 1 - Low

## SEMESTER II SKILL ENHANCEMENT COURSE I: POULTRY FARMING

Course Code	L	T	P	S	Credits	Inst. Hours	Total hours	Marks		
								CIA	External	Total
ZP232SE1	2	1		1	2	4	60	25	75	100

Pre-requisite

Students should be aware of economic and cultural importance of Poultry farming.

### Learning Objectives:

1. To know the needs for Poultry farming and the status of India in global market.
2. Acquire the skills to apply the techniques and practices needed or Poultry farming.

### Course Outcomes:

On the successful completion of the course, students will be able to:		
1.	recall the key components of a poultry house to ensure optimal living conditions for poultry.	<b>K1</b>
2.	explain the different methods of rearing and the significance of proper vaccination programs in poultry farming.	<b>K2</b>
3.	develop a practical feeding plan for a specific stage of poultry considering their nutritional requirements.	<b>K3</b>
4.	analyze the impact of different housing systems on poultry welfare and productivity,	<b>K4</b>
5.	critically assess the effectiveness of poultry feeds and the disease control measures in poultry farming,	<b>K5</b>
6.	design a comprehensive waste management and recycling system for poultry farms.	<b>K6</b>

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

Unit	Contents	No. of hours
I	General introduction to poultry farming - Definition of Poultry - Past and present scenario of poultry industry in India -Principles of poultry housing - Poultry houses - Systems of poultry farming	12
II	Management of chicks - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance.	12
III	Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.	12
IV	Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.	12
V	Selection, care and handling of hatching eggs - Egg testing. Methods of hatching. - Brooding and rearing -. Sexing of chicks. - Farm and Water Hygiene - Recycling of poultry waste.	12

### Text Books

1. Sreenivasaiah., P. V, 2015. *Textbook of Poultry Science*. 1st Edition. Write & Print Publications, New Delhi.
2. Jull A. Morley, 2007. *Successful Poultry Management*. 2nd Edition. Biotech Books, New Delhi.

### Reference Books



1. Jadhav, J, Siddique, M.F., KavithaMeena, 2019. *Handbook of Poultry Production and Management*. 3rd Edition. Jaypee Brothers Medical Publishers, Chennai.
2. Jagdish Prasad, 2015. *Poultry Production and Management Paperback – 1. 5h Edition* Kalyani Publishers, Chennai.
3. Das, D, 2021. *Textbook on Poultry Management*. Narendra Publishing House, New Delhi.
4. Eiri Board, 2008. *Hand Book of Poultry Farming and Feed Formulations*. Engineers India Research Institute. India.
5. Sharma R P et al. *Poultry Production in India*. Poultry Science, India.

### Web Resources

1. <https://dahd.nic.in/sites/default/files/Excerpts%20of%20Poultry%20Farmn%20Manual.pdf>
2. <https://www.fao.org/3/i3531e/i3531e.pdf>
3. <https://egyankosh.ac.in/bitstream/123456789/59735/1/Poultry%20farming%20in%20india.pdf>
4. <https://seyianwo.files.wordpress.com/2015/04/poultry-lecture-note.pdf>
5. [https://surendranathcollege.ac.in/new/upload/SUMAN\\_TAMANGPoultry%20Farming2021-02-14Poultry%20Farming-converted.pdf](https://surendranathcollege.ac.in/new/upload/SUMAN_TAMANGPoultry%20Farming2021-02-14Poultry%20Farming-converted.pdf)

### MAPPING WITH PROGRAMME OUTCOMES

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PSO 1	PSO2	PSO3	PSO4	PSO5
CO1	1	2	1	2	2	2	2	1	1	3	3	3
CO2	1	1	2	3	1	2	2	1	2	2	1	2
CO3	2	1	2	2	1	3	2	1	2	2	2	2
CO4	3	2	1	2	1	2	1	2	2	1	1	1
CO5	1	2	2	2	2	2	3	2	3	2	2	3
CO6	2	3	3	2	3	3	3	3	2	3	2	2
<b>Total</b>	13	11	11	14	10	14	13	10	12	13	11	13
<b>Average</b>	2.1	1.8	1.8	2.3	1.6	2.3	2.1	1.6	2	2.1	1.8	2.1

3 - Strong; 2 - Medium; 1-Low

## SEMESTER – I & II

### LIFE SKILL TRAINING – I ETHICS

Course Code	L	T	P	S	Credits	Inst. Hours	Total Hours	Marks		
								CIA	External	Total
PG23LST1	1				1	1	1	-	50	100

**Prerequisites:** Value education-its purpose and significance in the present world

## Learning Objectives

1. To familiarize students with values of the individual, society, culture, one's own health and life philosophy,
2. To impart knowledge of professional ethical standards, codes of ethics, obligations, safety, rights, and other worldwide challenges.

Course Outcomes	On completion of this course the student will be able to	
CO1	understand deeper insight of the meaning of their existence.	K1
CO2	recognize the philosophy of life and individual qualities	K2
CO3	acquire the skills required for a successful personal and professional life.	K3
CO4	develop as socially responsible citizens.	K4
CO5	create a peaceful, communal community and embrace unity.	K3

Unit	Contents	No. of Hours
I	<b>Goal Setting:</b> Definition - Brainstorming Session – Setting Goals – Few components of setting goals.	3
II	<b>Group Dynamics:</b> Definition - Nature of Groups – Types of Groups – Determinants of group behavior	3
III	<b>Conflict Resolution:</b> Definition – What is a conflict resolution – Why should conflicts be resolved? - Lessons for life	3
IV	<b>Decision Making:</b> Definition – 3C's of decision making – Seven Steps to effective decision making – Barriers in effective decision making	3
V	<b>Anger Management:</b> Effects of anger – Tips to reduce anger – Anger warning signs – Identify your triggers – Ways to cool down your anger.	3
<b>TOTAL</b>		<b>15</b>
<b>Self-Study Portion:</b> Salient values for life, Human Rights, Social Evils and how to tackle them, Holistic living, Duties and responsibilities.		

## Textbooks

Life Skill Training – I Ethics, Holy Cross College (Autonomous), Nagercoil

## Reference Books

1. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

2. Mathew, Sam (2010). Self Help Life Book. Opus Press Publisher.
3. Swati Mehrotra. (2016). Inspiring Souls Moral Values and Life Skills (1st ed.) [English]. Acevision Publisher Pvt. Ltd.
4. IraiAnbu, v. (2010, August). Random Thoughts (1st ed.) [English]. THG Publishing Private Limited, 2019.
5. Holy Cross College (Autonomous), Nagercoil (2007). Foundation Course Life's Challenges. Sipca Computers.

## Web Resources

1. <https://positivepsychology.com/goal-setting-exercises/>
2. [https://www.gov.nl.ca/iet/files/CCB\\_GroupDynamicsGuide.pdf](https://www.gov.nl.ca/iet/files/CCB_GroupDynamicsGuide.pdf)
3. [https://en.wikipedia.org/wiki/Conflict\\_resolution](https://en.wikipedia.org/wiki/Conflict_resolution)
4. <https://asana.com/resources/decision-making-process>
5. <https://www.mayoclinic.org/healthy-lifestyle/adult-health/in-depth/anger-management/art-20045434>

	<b>Content addressed with Local Needs</b>
	<b>Content addressed with National Needs</b>
	<b>Content addressed with Regional Needs</b>
	<b>Content addressed with Global Needs</b>