

## Department of Zoology (PG)

### Programme Specific Outcomes (PSOs)

On the successful completion of the Postgraduate programme, the students will be able to

<b>PSO1 Disciplinary Knowledge</b>	develop understanding and application of concepts at the taxonomic, cellular, ecological, embryonic, genetic, molecular, physiological and computational level.
<b>PSO2 Communication Skills</b>	equip to develop competency in communication skills, research, reasoning and teaching.
<b>PSO 3 Problem Solving &amp; Analytical Reasoning</b>	achieve proficiency in analysis, comprehension and assessing concepts related to zoology.
<b>PSO 4 Critical Thinking</b>	foster proficiency in interdisciplinary branches for better understanding of the concepts in zoology.
<b>PSO 5 Research Skills</b>	design projects to conduct independent study and derive data, document and develop new concepts.
<b>PSO 6 Digital Literacy</b>	analyse biological data and familiarize with digital learning.
<b>PSO 7 Professional competencies</b>	demonstrate professional competence and entrepreneurial skills in different areas of zoology.
<b>PSO 8 Moral and Ethical Awareness/Reasoning</b>	inculcate ethics, scientific temper and independent lifelong learning experience.
<b>PSO 9 Multicultural Competence</b>	develop practical knowledge & competence to interact with others in various fields of animal sciences.
<b>PSO 10 Self-directed &amp; Lifelong Learning</b>	evaluate issues related to conservation, ecology, environment, find solutions and to promote self-directed, lifelong learning.

**Department of Zoology (PG)**

**Learning Outcomes - based Curriculum Framework (LOCF)**

(w.e.f 2024-2025)

Sem	Category	Course Code	Course Title	Hours/ Wk.	Credits	Marks
1	CC	24PGZ4401	Comparative anatomy of Invertebrates & Vertebrates	5	4	80
1	CC	24PGZ4501	Biological Chemistry	6	5	100
1	CC	24PGZ4403	Cell Biology	5	4	80
1	CC	24PGZ4201	Biochemistry & Cell Biology Lab	4	2	40
1	DSE	24XXXNNNN	<i>Discipline Specific Elective I</i>	6	5	100
1	GE	24XXXNNNN	<i>Generic Elective I</i>	4	3	60
<b>Total</b>				<b>30</b>	<b>23</b>	<b>460</b>
2	CC	24PGZ4402	Animal Physiology	5	4	80
2	CC	24PGZ4404	Genetics	5	4	80
2	CC	24PGZ4502	Molecular Biology	6	5	100
2	CC	24PGZ4302	Animal Physiology & Molecular Biology Lab	5	3	60
2	DSE	24XXXNNNN	<i>Discipline Specific Elective II</i>	5	4	80
2	GE	24XXXNNNN	<i>Generic Elective II</i>	4	3	60
<b>Total</b>				<b>30</b>	<b>23</b>	<b>460</b>
3	CC	24PGZ5501	Entomology	6	5	100
3	CC	24PGZ5401	Evolution	5	4	80
3	CC	24PGZ5503	Immunology	6	5	100
3	CC	24PGZ5201	Entomology & Immunology Lab	4	2	40
3	CC	24PGZ5403	Bioinformatics (TcL)	6	4	80
3	DSE	24XXXNNNN	<i>Discipline Specific Elective III</i>	3	3	60
3	IS	24PGZ5233	Internship*	-	2	40
<b>Total</b>				<b>30</b>	<b>25</b>	<b>500</b>

4	CC	24PGZ5402	Biotechnology	5	4	80
4	CC	24PGZ5404	Developmental Biology	5	4	80
4	CC	24PGZ5406	Ecology	5	4	80
4	CC	2P4GZ5302	Biotechnology, Developmental Biology & Ecology Lab	6	3	60
4	DSE	24XXXNNN	<i>Discipline Specific Elective IV</i>	3	2	40
4	CC	24PGZ5601	Project	6	6	120
4	SEC	24PGZ5244	Professional Competency Skill	-	2	40
<b>Total</b>				<b>30</b>	<b>25</b>	<b>500</b>
<b>Grand Total</b>				<b>120</b>	<b>96</b>	<b>1920</b>

\* Internship - First Year Vacation (30 Hours)

### Discipline Specific Elective (DSE)

Sem	Category	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	DSE	24PGZ4503	Microbiology (TcL)	6	5	100
	DSE	24PGZ4505	Medical Lab Technology (TcL)	6	5	100
2	DSE	24PGZ4406	Biostatistics and Research Methodology	5	4	80
	DSE	24PGZ4408	Aquaculture	5	4	80
3	DSE	24PGZ5301	Applied Zoology	3	3	60
	DSE	24PGZ5303	Animal Behaviour	3	3	60
4	DSE	24PGZ5202	Wildlife Biology	3	2	40
	DSE	24PGZ5204	Nanobiology	3	2	40

### Generic Elective (GE)

Sem	Category	Course Code	Course Title	Hours/Wk.	Credits	Marks
1	GE	24PGZ4301	Know Your Body	4	3	60
	GE	24PGZ4303	Nutrition and Dietetics	4	3	60
2	GE	24PGZ4304	Poultry Farming	4	3	60
	GE	24PGZ4306	Introduction to Ornithology	4	3	60

### Mapping with POs

PGZ	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	3	3	3	2	3	3	3	2	2	2

### Mapping of Courses with PSOs

Course Code	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
24PGZ4401	3	2	2	2	2	2	1	2	1	2
24PGZ4501	3	3	2	2	2	2	2	2	2	1
24PGZ4403	3	3	3	2	2	2	2	2	2	1
24PGZ4201	3	2	3	2	3	2	2	3	3	1
24PGZ4503/ 24PGZ4505	3	3	3	3	3	2	3	3	3	2
24PGZ4402	3	3	2	2	1	2	1	2	1	2
24PGZ4404	3	3	3	2	2	3	2	2	2	1
24PGZ4502	3	3	3	3	3	3	2	2	2	1
24PGZ4302	3	3	3	2	3	3	2	3	3	1
24PGZ4406/ 24PGZ4408	3	3	3	3	3	2	3	3	3	2
24PGZ5501	3	3	2	3	3	2	2	2	3	2
24PGZ5401	3	3	2	3	2	3	2	3	3	1
24PGZ5503	3	3	3	3	2	2	2	3	3	2
24PGZ5201	3	2	3	3	3	3	3	3	2	1

24PGZ5403	3	3	3	3	3	3	2	2	3	1
24PGZ5301/ 24PGZ5303	3	3	3	3	3	3	3	3	3	3
24PGZ5233	2	3	3	3	3	3	3	3	3	3
24PGZ5402	3	3	3	2	3	3	3	3	2	1
24PGZ5404	3	3	2	1	2	2	1	3	2	3
24PGZ5406	3	3	2	2	3	3	2	2	2	3
2P4GZ5302	3	3	3	3	3	3	3	2	2	2
24PGZ5202/ 24PGZ5204	3	3	2	2	3	3	3	2	2	3
24PGZ5601	3	3	3	3	3	3	2	2	3	3
24PGZ5244	3	3	2	2	1	3	3	2	3	3
<b>Average</b>	2.8	2.8	2.5	2.4	2.5	2.5	2.2	2.4	2.3	1.8

### Mapping of Courses with POs

Course Code	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
24PGZ4301/ 24PGZ4303	3	3	2	1	1	3	2	2	1	2
24PGZ4304/ 24PGZ4306	3	3	2	2	3	2	3	2	1	2
<b>Average</b>	3	3	2	1.5	2	2.5	2.5	2	1	2

Course Code	Name of the Course	Category	Hours/wk	Credits
24PGZ4401	Comparative Anatomy of Invertebrates & Vertebrates	Core	5	4

This course aims at refreshing the fundamental aspects of invertebrates and chordates. It provides adequate facts which will enrich the knowledge in Zoology. It deals with broad outline classification of invertebrates and chordates in relation to their functional morphology.

**Course Outcomes:**

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

- CO1:** Outline the concept of taxonomy, classification and characteristic features of major group of invertebrates and vertebrates.
- CO2:** Explain different physiological body processes of invertebrates.
- CO3:** Analyse complex interactions among the various animals of different phyla, their distribution and their relationship with the environment.
- CO4:** Correlates the relationship of organ systems.
- CO5:** Explain specific knowledge of several vertebrate organ systems, including skeletal and sense organs.

**UNIT I: (15 Hours)**

**Structural organization of Invertebrates:** Taxonomy -types of taxonomy - morphology, numerical, molecular and phyletic lineages. Concepts of species - IUCN nomenclature. Outline classification of Invertebrates. Hierarchical organization of animal complexity - unicellular, colonial & multicellular forms, coelom, symmetry, organs and systems. Locomotion: Flagella and ciliary movement in Protozoa; Hydrostatic movement in Coelenterata, Annelida and Echinodermata.

**UNIT II: (15 Hours)**

**Digestion & Excretion in invertebrates:** Patterns of feeding and digestion in lower metazoan; Filter feeding in Polychaeta, Mollusca and Echinodermata. Organs of excretion: coelom, coelomoducts, Nephridia and Malphigian tubules.

**UNIT III: (15 Hours)**

**Respiration & Nervous system in invertebrates:** Respiration: Organs of respiration: Gills, lungs and trachea. Primitive nervous system: Coelenterata and Echinodermata; Advanced nervous system: Annelida, Arthropoda (Crustacea and Insecta) and Mollusca (Cephalopoda).

**UNIT IV: (15 Hours)**

**Anatomy of Vertebrates I:** Outline classification of Vertebrates. Vertebrate integument and its derivatives. Development, general structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, feathers and hairs. General plan of circulation in vertebrates; Evolution of heart; Evolution of aortic arches and portal systems. Comparative account of respiratory organs

**UNIT V: (15 Hours)**

**Anatomy of Vertebrates II:** Form, function, body size and skeletal elements of the body - Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles - Evolution of Urinogenital system in vertebrate. Simple receptors; Organs of Olfaction and taste; Lateral line system; Electroreception. Comparative anatomy of the brain in relation to its functions; Comparative anatomy of spinal cord and nerves.

**Learning Resources:**

**Text Books**

1. Barrington, E. J.W (1979). Invertebrate Structure and Function. The English Language Book Society and Nelson.
2. Ekambaranatha Ayyar and T. N. Ananthakrishnan (2009). Manual of Zoology, Vol – II, S. Viswanathan Pvt. Ltd. Chennai.
3. Kotpal, (2019). R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut.
4. Parker T. J. and W. A. Haswell (1962). A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London.
5. Waterman, A.J (1972). Chordate Structure and Function, MacMillan Co., New York.

## References

1. Barnes, R. D (1974). Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition.
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.
4. Hickman CPJR, Roberts SL and Larson A (2001). Integrated Principles of Zoology, Eleventh edn, McGraw-Hill publishers, New York.
5. Romer, A.S (1971). The Vertebrate body, W.B.S. Saunders, Philadelphia.
6. Yong, J. Z (1981). The life of Vertebrates, English language Book Society, London.

## Websites/ e-Learning Resources

1. [https://batrachos.com/sites/default/files/pictures/Books/Kardong\\_2019\\_Vertebrates%20comparative%20anatomy,%20function,%20evolution.pdf](https://batrachos.com/sites/default/files/pictures/Books/Kardong_2019_Vertebrates%20comparative%20anatomy,%20function,%20evolution.pdf)
2. <https://tnou.ac.in/NAAC/SSR/C1/1.1.5/MZON-12.pdf>
3. <https://www.sciencedirect.com/science/article/abs/pii/S0305049178902213>
4. <https://www.sciencedirect.com/science/article/pii/S0960982211007834>
5. <https://www.sciencedirect.com/topics/medicine-and-dentistry/comparative-anatomy>
6. <https://www.sciencedirect.com/science/article/abs/pii/B9781483228716500084>

## CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	1	3	2	2	2	2
CO2	3	2	2	1	2	2	1	2	1	2
CO3	3	2	12	2	2	2	1	2	1	2
CO4	3	2	2	2	1	2	1	2	1	1
CO5	3	2	2	2	1	2	1	2	1	1
Average	3	2	2	1.8	1.6	2.2	1.2	2	1.2	1.6

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4501	Biological Chemistry	Core	6	5

This course includes physical and chemical concepts in biology, composition, structure and functions of carbohydrates, proteins, lipids and vitamins. Enzymes & enzyme kinetics, metabolism of carbohydrates, proteins, lipids, and vitamins will be taught. It also includes biosynthesis and degradation of purines and pyrimidines.

**Course Outcomes:**

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

**CO1:** Explain the basic concepts of biochemistry such as chemical bonds, pH, buffer.

**CO2:** Describe the structures of carbohydrates, proteins, lipids and vitamins and their functions.

**CO3:** Outline the mechanisms of enzyme catalysis and the role of thermodynamic principles in metabolic reactions.

**CO4:** Discuss the metabolic pathways of carbohydrates and vitamins.

**CO5:** Evaluate the metabolic pathways of amino acid, nucleic acid and lipids.

**UNIT I: (18 Hours)**

**Laws of physics and chemistry in Biology:** Structure of atoms, molecules and chemical bonds. Biomolecule interaction - van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction and covalent bond. Principles of biophysical chemistry- pH, buffer, reaction kinetics, colligative properties.

**UNIT II: (18 Hours)**

**Biomolecules:** Composition, structure, classification, function and biological significance - Carbohydrates, lipids, proteins and vitamins. Conformation of proteins - Ramachandran plot, primary, secondary, tertiary & quaternary structures, domains, motif and folds.

**UNIT III: (18 Hours)**

**Enzymology and bioenergetics:** Enzymes and enzyme kinetics - regulation of enzymatic activity - mechanism of enzyme catalysis – Michaelis - Menten equation -

isozymes. Bioenergetics - thermodynamics, free energy, coupled reactions, group transfer and biological energy transducers.

**UNIT IV: (18Hours)**

**Carbohydrate and vitamin metabolism:** Types of metabolism. Carbohydrate metabolism - glycolysis, TCA cycle, oxidative phosphorylation, Gluconeogenesis, glycogen metabolism - Glycogenesis and Glycogenolysis, HMP shunt, uronic acid pathway, Vitamin metabolism - vitamins A and C.

**UNIT V: (18 Hours)**

**Amino acid, nucleic acid and lipid metabolism:** Amino acid metabolism - Urea cycle. Nucleotides - Biosynthesis and degradation of purines and pyrimidines. Biosynthesis and  $\beta$ -oxidation of fatty acid, Ketone bodies, metabolism of Phospholipids, Glycolipids, Cholesterol and HDL.

**Learning Resources:**

**Text Books**

1. Voet JG, Pratt CW and Voet D (2016). Fundamentals of Biochemistry: Life at the molecular level, Fifth edn, John Wiley & Sons, New York.
2. Murray RK, Granner DK and Rodwell VW (2006). Harper's Illustrated Biochemistry, 27<sup>th</sup> edition, McGraw Hill Companies, Inc.
3. Nelson DL and Cox MM (2013). Lehninger Principles of Biochemistry, 6<sup>th</sup> edition, W.H. Freeman, New York.

**References**

1. Berg JM, Tymoczko L and Stryer L (2012). Biochemistry, 7<sup>th</sup> edition, W.H. Freeman, New York.
2. Satyanaraya U and Chakrapani U (2023). Biochemistry. 6<sup>th</sup> edition, Elsevier Publications.
3. Jain JL (2004). Fundamentals of Biochemistry. 7<sup>th</sup> edition. S. Chand Publishing.

**Websites/ e-Learning Resources**

1. [https://onlinecourses.nptel.ac.in/noc22\\_cy06/preview](https://onlinecourses.nptel.ac.in/noc22_cy06/preview)

2. <https://www.sciencedirect.com/book/9780723611516/guide-to-biochemistry>
3. <https://www.cliffsnotes.com/study-guides/biology/biochemistry-i>
4. <https://open.umn.edu/opentextbooks/textbooks/866>

### **CO – PSO Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	2	2	1
CO2	3	3	2	2	2	2	2	2	2	1
CO3	3	3	2	2	2	2	2	2	2	1
CO4	3	3	2	3	2	2	2	2	2	1
CO5	3	3	3	3	3	2	2	2	2	1
Average	3	3	2.2	2.4	2.2	2	2	2	2	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4403	Cell Biology	Core	5	4

This course enables the students to understand the ultra-structural organizations and functions of various components of cells. The course also envisages in imparting knowledge on intra-cellular and extra-cellular transport, membrane potentials. The course discusses about chromosomal organization, cell cycle & division, their regulation, cancer and the intervention measures

**Course Outcomes:**

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

**CO1:** Outline the structures, properties and functions of cell wall and cell membrane and tools used to study.

**CO2:** Describe the ultrastructures and functions of intra-cellular organelles.

**CO3:** Illustrate the levels of structural scaffolding in chromosomes and functions of nucleus and nucleolus.

**CO4:** Summarize the mechanism of inter-cellular signalling and communication

**CO5:** Relate cell cycle & division, their regulation with uncontrolled cellular development and ways to control it.

**UNIT I: (15 Hours)**

**General features of Cell:** Prokaryotes & Eukaryotes – outline – Ultra structure of cell wall – Cell membrane-Structure-Fluid Mosaic Model-components & properties of membrane – Transport across membranes-Osmosis, Diffusion (passive & facilitated), Active transport (pump proteins eg. Sodium potassium ATPase pump) – membrane potentials – Microscopy and microtechniques.

**UNIT II: (15 Hours)**

**Organelles:** Ultra structural organization and functions of Endoplasmic reticulum, Golgi apparatus, Lysosomes, Ribosomes, peroxisome, centrioles, plastids, mitochondria, chloroplast, cytoskeleton – intracellular traffic and protein sorting.

**UNIT III: (15 Hours)**

**Nucleus, nucleolus and Chromosome:** Nuclear membrane, Pore complex, Nucleolus, Chromosomes-structure, types-allosomes, autosomes – Giant chromosomes – DNA packaging – Euchromatin & Heterochromatin.

**UNIT IV: (15 Hours)**

**Cellular association and communication:** Extracellular matrix – cellular junctions- Occluding, anchorage and communication – Cell adhesion molecules – types of intercellular communication – Cell Surface Receptors – GPCRs – Signal transduction pathways, secondary messengers, regulation of signalling pathways.

**UNIT V: (15 Hours)**

**Cell cycle and Cancer:** Cell cycle-resting cell, steps, checkpoint and regulation – Cell division – Mitosis – meiosis – regulation - Oncogenes - tumour suppressor genes - cancer - metastasis - interaction of cancer cell with normal cell – apoptosis - therapeutic interventions of uncontrolled cell growth.

**Learning Resources:**

**Text Books**

1. De Robertis EDP and De Robertis EMF (2017). Cell and Molecular Biology, Eighth edn, BI Waverly Pvt. Ltd, New Delhi.
2. Lodish, H., C. A. Kaiser, A. Bretscher, *et al.*, (2013). Molecular Cell Biology (Seventh Edition), Macmillan, England

**References**

1. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P (2002). Molecular Biology of the Cell, Third edn, Garland Science Publisher, New York.
2. Karp G (2010). Cell Biology, Sixth edn, John Wiley & Sons, New York.
3. Kleinsmith LJ and Kish VM (1995). Principles of Cell and Molecular Biology, Second edn, Harper Collins College Publishers, New York.

### Websites/ e-Learning Resources

1. <https://www.nature.com/scitable/topic/cell-biology-13906536>
2. <https://www.britannica.com/science/cell-biology>
3. <https://plato.stanford.edu/entries/cell-biology>
4. <https://www.embl.org/research/units/cell-biology-biophysics>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	2	2	2	2	2	1
CO2	3	3	3	2	2	2	2	2	2	1
CO3	3	3	3	3	2	2	2	2	2	1
CO4	3	2	3	2	2	2	2	2	2	1
CO5	3	2	3	2	2	2	2	2	2	1
Average	3	2.8	3	2.2	2	2	2	2	2	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4201	Biochemistry & Cell Biology Lab	Core	4	2

Biological Chemistry laboratory component includes pH metry, colorimetric estimation of biomolecules, centrifugation, chromatographic separation of amino acids, electrophoresis and enzyme kinetics. The Cell Biology laboratory component emphasizes on the working principle of compound microscope, observation of specialized cells, micrometry, permanent slide preparation, observation of mitosis in onion root tip and polytene chromosomes in Chironomus larva.

#### **Course Outcomes:**

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

**CO1:** Outline the principles of biochemical techniques.

**CO2:** Estimate biomolecules and enzyme activity.

**CO3:** Perform experiments using colorimeter, centrifuge and chromatograph.

**CO4:** Identify various types of cells utilizing microscopic techniques.

**CO5:** Demonstrate membrane properties, cell division and types of chromosomes.

### **I. Lab. in Biological Chemistry**

#### **Laboratory Exercises:**

1. pH metry.
2. Preparation of biological buffer.
3. Colorimetry.
4. Estimation of Glucose -Anthrone method.
5. Estimation of Protein - Lowry's method.
6. Estimation of DNA by Diphenylamine reaction.
7. Estimation of RNA by Orcinol reagent.
8. Centrifugation technique.
9. Chromatography: Paper and Thin Layer
10. Enzyme assay - alkaline phosphatase activity
11. Enzyme kinetics using alkaline phosphatase

## II. Lab. in Cell Biology

### Laboratory Exercises:

1. Microscopic observation of specialized cells (nerve cell, muscle cell etc).
2. Outline sketch of cells using Camera Lucida.
3. Micrometry.
4. Permanent slide preparation phase I – principle, fixation, dehydration, embedding.
5. Permanent slide preparation phase II – sectioning, staining and mounting.
6. Study of mitosis using onion root tip.
7. Preparation of polytene chromosomes from salivary glands of Chironomus larvae
8. Plasmolysis – with different plant cells with different NaCl and sucrose solution concentration.
9. Hemolysis I – Principle, influence of NaCl solution of various concentrations.
10. Hemolysis II – Influence of temperature, molecular size, organic solvents.
11. Observation of cell division stages using permanent slides.

### Learning Resources:

#### References

1. Jayaraman J (2011). Laboratory manual in Biochemistry, Second edn, New Age International Publishers, New Delhi.
2. Karp G (1996). Cell and Molecular Biology-concepts and experiments, John Wiley and Sons Inc. New York.
3. Gasque EA (1992). Manual of laboratory experiences in Cell Biology, Universal Bookstall, New Delhi.
4. Palanivelu P (2009). Analytical Biochemistry and Separation Techniques, Fourth edn, Twenty-first Century Publications, Madurai.
5. Plummer DT (1997). An introduction to practical Biochemistry, Tata McGraw Hill Publishing Company, New Delhi.

#### Websites/ e-Learning Resources

1. <https://www.biologysimulations.com>
2. <https://www.allencell.org/all-educational-resources.html>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	2	3	2	2	3	3	1
CO2	3	2	3	2	3	2	2	3	3	1
CO3	3	2	3	2	3	2	2	3	3	1
CO4	3	2	3	2	3	2	2	3	3	1
CO5	3	2	3	2	3	2	2	3	3	1
Average	3	2	3	2	3	2	2	3	3	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

<b>Course Code</b>	<b>Name of the Course</b>	<b>Category</b>	<b>Hours/Wk.</b>	<b>Credits</b>
24PGZ4503	Microbiology (TcL)	DSE	6	5

This theory cum lab course is designed to understand the basic and applied areas of microbiology. It deals with detailed classification of bacteria, algae, fungi, protozoa and viruses. It imparts knowledge of microorganisms in industrial, food and agricultural microbiology. It emphasizes primary and secondary screening of microbes linked with fermentation industry. The course also deals with medically important microbes, diseases and control measures in terms of public health.

**Course Outcomes:**

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

**CO1:** Outline the evidences, diversity and scope of microbiology and classify microbial world.

**CO2:** Explicate various bacterial growth media, sterilization, growth curve and microbial metabolism.

**CO3:** Assess the significance of microbes in environment.

**CO4:** Apply the knowledge of microorganisms in food and industrial sectors.

**CO5:** Analyze the role of microorganisms in epidemic and communicable diseases in global perspectives.

**UNIT I: (12 Hours)**

**General Microbiology:** Scope and History of Microbiology, Structure & function of microbial cells – Microbial Taxonomy –identification and classification, phylogeny– Primitive and Advanced classification of bacteria, Classification system of algae, fungi, protozoa and viruses.

**UNIT II: (12 Hours)**

**Microbial Physiology:** Nutritional types of microbes - Culture media - Bacterial cell cycle –Growth curve - Measurement – Factors influencing microbial growth – Thermal death Time - Physical and chemical methods of sterilization - Chemotaxis and endospore formation - Microbial metabolism - Oxidation-reduction reactions.

**UNIT III: (12 Hours)**

**Microbial Ecology:** Global climate changes - Assessing microbial diversity. Water as a microbial habitat - Marine and freshwater ecosystems - Coliform analysis. Water purification and sanitary analysis - Sewage treatment and recycling of wastes. Soil as a microbial habitat - Plant-microbe associations - Nitrogen fixation - Mycorrhizae.

**UNIT IV: (12 Hours)**

**Food and Industrial Microbiology:** Microbial Spoilage of Vegetables, Meat, Fish & Poultry products – methods of Preservation. Food borne diseases –Salmonellosis and Botulism. Screening of industrial important microbes - scale up –Types of fermentors – Industrial production of Penicillin, Vitamin B12, and Vinegar- Applications of microbial products in human welfare.

**UNIT V: (12 Hours)**

**Medical microbiology and Public health:** Normal Microbiota in man - Epidemiology - Infectious disease cycle– Nosocomial infections. Causative agents, transmission, symptoms, clinical manifestations, diagnosis and control measures of Tuberculosis, Aspergillosis, Malaria, AIDS and COVID. Antimicrobial drugs – generation of antibiotics - bioterrorism

**Learning Resources:**

**Text Book**

1. Willey JM, Sherwood LM and Woolverton CJ (2016). Prescott's Microbiology, Tenth edn, McGraw Hill International publication, New York.

**References**

1. Black JG (2012). Microbiology- Principles and Exploration, Eighth Edn, John Wiley & Sons, INC.
2. Kapil A and Bhaskaran CS (2013). Ananthanarayan and Paniker's Textbook of Microbiology, Ninth edn, University Press.
3. Pelczar MJJR, Chan ECS and Krieg NR (1993). Microbiology, Fifth edn, Tata McGraw-Hill, New Delhi.

### **Websites/ e-Learning Resources**

1. <https://study.com/academy/course/microbiology-syllabus-resource-lesson-plans.html>
2. [https://elearning.icar.gov.in/DisplayPG\\_ECoursesContent.aspx?CourseCode=Bvr2o2ak8iLXwyWI6719Sw==#!](https://elearning.icar.gov.in/DisplayPG_ECoursesContent.aspx?CourseCode=Bvr2o2ak8iLXwyWI6719Sw==#!)
3. <https://www.scienceprofonline.com/instructors-corner/instructors-corner-vmc.html>
4. <https://microbenotes.com/category/diseases/>
5. [https://www.sciencedaily.com/news/plants\\_animals/microbiology/](https://www.sciencedaily.com/news/plants_animals/microbiology/)

### **Lab. in Microbiology**

#### **Laboratory Exercises:**

1. Aseptic techniques - sterilization methods and preparation of media (selective and differential).
2. Pure culture isolation and maintenance from air - water - soil.
3. Staining techniques and biochemical tests to classify microbes.
4. Cultivation and identification of unknown Fungi from various sources.
5. Antimicrobial susceptibility test using Kirby Bauer method.
6. Methylene blue reductase test of milk.
7. Wine Production
8. Primary and secondary screening of industrially relevant microbes.
9. Isolation and characterization of microbes from sewage sample.
10. Isolation and maintenance of pure culture of actinomycetes.
11. Screening for antibiotic producing organism from soil.
12. Isolation of Nitrogen fixing bacteria from Root nodule.
13. Isolation of Normal microbiota of Human body.
14. Identification of Nosocomial infection causing organisms.
15. Visit to Industry/Hospital/fermentation unit

#### **References**

1. Aneja RK (2014). Laboratory Manual of Microbiology and Biotechnology, First edn, Medtech Publication.

2. Cappucino GS and Sherman N (2013). Microbiology-A Laboratory Manual, Tenth edn, Pearson Education.
3. Gasque EA (1992). Manual of laboratory experiences in Cell Biology, Universal Bookstall, New Delhi.
4. Gunasekaran P (1995). Laboratory manual in Microbiology, New Age International Pvt. Ltd, New Delhi.
5. Jayaraman J (2011). Laboratory manual in Biochemistry, Second edn, New Age International Publishers, New Delhi.
6. Karp G (1996). Cell and Molecular Biology-concepts and experiments, John Wiley and Sons Inc. New York.
7. Palanivelu P (2009). Analytical Biochemistry and Separation Techniques, Fourth edn. Twenty first Century Publications

#### **Websites/ e-Learning Resources**

1. <https://vlab.amrita.edu/?sub=3&brch=73>
2. <https://learn.chm.msu.edu/vibl/>
3. <https://mvi-au.vlabs.ac.in/>
4. <https://virtuallab.tlc.ontariotechu.ca/intro.php>
5. <https://www.merlot.org/merlot/viewMaterial.htm?id=79694>

#### **CO – PSO Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	3	2	2	2	3	1
CO2	3	3	2	2	3	3	2	3	3	1
CO3	3	3	3	2	3	2	3	3	3	3
CO4	3	3	3	2	3	3	3	3	3	2
CO5	3	3	2	2	3	2	2	3	3	3
Average	3	3	2.4	2	3	2.4	2.4	2.8	3	2.

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

<b>Course Code</b>	<b>Name of the Course</b>	<b>Category</b>	<b>Hours/wk</b>	<b>Credits</b>
24PGZ4505	Medical Lab Technology (TcL)	DSE	6	5

This course is intended to impart knowledge on various aspects of medical laboratory technology such as role of a medical laboratory personnel, good laboratory practices, cleaning and sterilization methods and personal hygiene and health. It also deals with theoretical and laboratory procedures for various haematological, microbiological and histological methods of diagnosing clinical samples. Besides, the course explains the applications of different medical laboratory equipment used for accurate diagnosis.

### **Course Outcomes:**

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

**CO1:** Outline the organization of a medical lab, good laboratory practices, cleaning, sterilization methods and personal hygiene and health practices of a medical lab technician.

**CO2:** Assess the blood specimen.

**CO3:** Interpret results from various medical lab reports and microbial tests.

**CO4:** Employ the appropriate test to identify cardiac related conditions.

**CO5:** Examine tissue sample and perform histological processing.

### **UNIT I: (12 hours)**

**Scope of medical laboratory technology:** Laboratory principles-infrastructure of clinical laboratory - Role of medical laboratorian - Laboratory safety - toxic chemicals and biohazard wastes- biosafety level - biosafety symbols, good laboratory practice - safety measures-cleaning and sterilization methods, hospital and clinic borne infection and personnel hygiene, health issue and job opportunities.

### **UNIT II: (12 hours)**

**Composition of blood and its function:** Haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count (RBC) - Differential count (WBC)- blood grouping and typing- haemostasis- bleeding

disorder of man – Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count. Blood bank techniques, collection and storage, separation of plasma.

**UNIT III: (12 hours)**

**Definition and scope of microbiology:** Structure & function of cells - Parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome. Computer tomography (CT scan) - Magnetic Resonance imaging - flowcytometry - treadmill test - PET. Physiology effect of alcohol, tobacco smoking, junk food & its treatment - biomedical waste management.

**UNIT IV: (12 hours)**

**Cardiovascular system and techniques of sample processing:** Blood pressure - Pulse - regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) - significance - ultra sonography-Electroencephalography (EEG). Techniques of sample processing; Throat swab, sputum, blood, urine, stool, pus, CSF, other body fluids.

**UNIT V: (12 hours)**

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

**Learning Resources:**

**Text Books**

1. Godker, P. B. and Godker, D. P (2024). Text book of Medical Laboratory Technology-Clinical Laboratory Science and Molecular Diagnosis. 4<sup>th</sup> Edition. Bhalani Publishing House, India.
2. Sood, R (2009). Medical Laboratory Technology, Methods and Interpretation. 6<sup>th</sup> Edition. Jaypee Brothers Medical Publishers (P) Ltd., India.

3. Guyton and Hall (2000). Text Book of medical Physiology, 10th edition, Elsevier, New Delhi.
4. Mukerjee, K.L (1999). Medical Laboratory Technology- Vol, I, II, III. Tata MC Graw Hill, New Delhi.

### **References**

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

### **Websites/ e-Learning Resources**

1. <https://nios.ac.in/online-course-material/vocational-courses/dmlt.aspx>
2. <https://study.com/academy/course/mlt-ascp-medical-laboratory-technician-study-guide-exam-prep.html>
3. <https://www.dpgpolytechnic.com/diploma-in-medical-lab-technician90.html?CID=67>
4. <https://www.picmonic.com/pricing/medical-lab-technician>
5. <https://gppanchkula.ac.in/e-notes-medical-lab-technology/>

## **Lab in Medical Lab Technology**

### **Laboratory Exercises:**

1. Cleaning, sterilization of laboratory wares and general maintenance of equipment.
2. Physical examination of urine-colour, turbidity, microscopic observation
3. Urine albumin examination.
4. Examination of Bile salt, Bile pigments and Urobilinogen in urine sample.
5. Estimation of Erythrocyte Sedimentation Rate (ESR) and haemoglobulin.
6. Glucose tolerance test.
7. Quantification of serum creatinine.
8. Estimation of serum cholesterol.
9. Bacteriological testing of urine and sputum samples.

10. Determination of typhoid by Widal test.
11. Microscopic examination of Malaria, Entamoeba.
12. Visit to modern clinical diagnostic laboratory.

### References

1. Jacqueline H. Carr; Bernadette F. Rodak (2009). Clinical Hematology Atlas, 3rd Ed. Mulford Book Stacks.
2. Denise M. Harmening (2002). Clinical hematology and fundamentals of hemostasis, 4th. ed. by Mulford Book Stacks.

### Websites/ e-Learning Resources

1. [https://webstor.srmist.edu.in/web\\_assets/srm\\_mainsite/files/files/3%20ESTIMATION%20OF%20SUGAR.pdf](https://webstor.srmist.edu.in/web_assets/srm_mainsite/files/files/3%20ESTIMATION%20OF%20SUGAR.pdf)
2. <https://www.youtube.com/watch?v=ac8gXAvHSPo>
3. [https://www.youtube.com/watch?v=xms7\\_GoRkck](https://www.youtube.com/watch?v=xms7_GoRkck)
4. <https://www.youtube.com/watch?v=jLBeOORYaK4>
5. <https://www.practo.com/tests/hiv-tridot-test-immunoassay-blood/p#:~:text=HIV%20Tridot%20Test%20Immunoassay%20blood%20test%20uses%0a%20sample%20of,1%20and%20HIV%2D2%20antigens>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	3	3	3	2
CO2	3	3	3	3	3	2	3	3	3	2
CO3	3	3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	2	3	3	3	2
CO5	3	3	3	3	3	2	3	3	3	2
Average	3	3	3	3	3	2	3	3	3	2

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4301	Know Your Body	GE	4	3

It is a comprehensive course that aims to give a basic understanding on the anatomical and physiological features of various organ systems like digestive, respiratory, circulatory, nervous, endocrine, excretory and reproductive systems in human beings. This course also deals with some areas in health and hygiene.

**Course Outcome:**

At the end of this course, the students will be able to

**CO1:** Discuss the nutritional requirements, structure and functions of digestive system.

**CO2:** Explain the structure and functions of skeletal, muscles and central nervous system.

**CO3:** Demonstrate the physiology of circulatory and respiratory system.

**CO 4:** Outline the organs of excretory and reproductive system and their disorders.

**CO 5:** Apply their knowledge to maintain Health and Hygiene.

**UNIT I: (12 Hours)**

**Nutrition, diet and digestive system:** Carbohydrates - Fats - Proteins - Caloric values of food - Obesity & BMI. Minerals - Vitamins - Deficiency disorders. Organs of digestive system - digestion and absorption.

**UNIT II: (12 Hours)**

**Skeletal, muscular and nervous systems:** Bones - cartilage - ligaments - tendons - muscles - disorders. Nervous system - brain, sensory organs - skin, tongue, nose, eye and ear.

**UNIT III: (12 Hours)**

**Respiratory and circulatory systems:** Lungs - respiration - respiratory disorders. Heart - structure, functions and cardiac disorders Blood - composition - blood groups - Rh factor - blood clotting - transfusion - blood Bank.

**UNIT IV: (12 Hours)**

**Excretory and reproductive systems:** Kidney - structure and function - disorders. Male and female reproductive organs - hormones - IVF - Sexually transmitted diseases.

**UNIT V: (12 Hours)**

**Health and Hygiene:** Environment and health - Sleep - sleep disorders - World awareness days on health - silent killer disorders - Nosocomial infections - Personal hygiene and occupational disorders - stress.

**Learning Resources:**

**Text Books**

1. Vander AJ, Sherman JH and Luciano DS (2001). Human Physiology: The Mechanism of Body Function, Eighth edn, McGraw Hill Inc. New Delhi.
2. Hall JE (2015). Guyton and Hall textbook of medical physiology, Thirteenth edn, Saunders (Elsevier), Canada.

**References**

1. Mader SS and Windelspecht M (2018). Human Biology, Fifteenth edn, McGraw-Hill Education, New York.
2. Taylor DJ, Green NPO and Stout SW (2005). Biological Science, R. Soper (ed.), Third edn, Cambridge University Press, UK.

**Websites/ e-Learning Resources**

1. <https://www.khanacademy.org/science/biology/human-biology/circulatory-pulmonary/v/the-lungs-and-pulmonary-system>
2. <https://www.khanacademy.org/science/biology/human-biology/circulatory-pulmonary/v/red-blood-cells>
3. <https://www.visiblebody.com/learn/muscular>
4. <https://open.umn.edu/opentextbooks/textbooks/576>

### CO – PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	2	2	2	2	2	2	1	3
CO 2	3	3	2	1	1	3	2	1	1	2
CO 3	3	3	2	1	1	2	2	2	1	2
CO 4	3	3	2	1	1	2	2	2	1	2
CO 5	3	3	2	1	1	2	2	2	1	2
Average	3	3	2	1.2	1.2	2.2	2	1.8	1	2.2

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
23PGZ4303	Nutrition and Dietetics	GE	4	3

This course is aimed to understanding the basis of nutrition and their effects on health. It clarifies the role of specific foods in prevention and management of diseases. It inculcates knowledge on healthy life style and ethical principles in nutrition.

### Course Outcome

At the end of the course the students will be able to:

**CO1:** Classify the sources of food and their role in good health.

**CO2:** Summarize the nutritional value of food.

**CO3:** Outline the nutritional requirements at various stages of growth and development

**CO4:** Analyze the role of diet and nutrition in prevention and management of diseases

**CO5:** Demonstrate the methods of nutritional assessment and the role of National and International organizations in nutrition management.

### UNIT I: (12 Hours)

**Introduction and classification of food:** Food as source of nutrients - classification and functions of food, composition – food groups- Daily requirements, Functions and deficiency diseases of carbohydrates, proteins, fats, fiber, vitamins and minerals. Water and electrolyte balance.

### UNIT II: (12 Hours)

**Nutritive value of foods:** Introduction - milk - egg – meat - fish – pulses – legumes - Fruits – green leafy vegetables. Food habits – BMR – measurement – factors affecting BMR- balanced diet – malnutrition – under nutrition.

### UNIT III: (12 Hours)

**Nutrition on growth and development:** Nutrition at various stages of growth and development- Infants, Children, adolescent, pregnant women, lactating mother. Geriatric nutrition. Energy Balance - Energy Requirements -men and women.

**UNIT IV: (12 Hours)**

**Diet in Disease Management:** Role of diet and nutrition in prevention and management of diseases - obesity- diabetes - hypertension- ulcer - anemia - dental caries- myocardial infarction & rheumatic disorders - food allergic conditions.

**UNIT V: (12 Hours)**

**Nutritional Assessment and Organizations:** Methods of assessments-Calorific value of food- bomb calorimeter - Assessment of Food adulteration - Role of RDA - Minimal Nutritional Requirements - Formulation of RDA and Dietary Guidelines, FAO, PAHO, WFP.

**Learning Resources:**

**Text Books**

1. Shubangini A Joshi (1998). Nutrition and Dietetics, Tata Mc Graw Hill Pub. Co. Ltd., New Delhi.
2. Srilakshmi. B (2005). Dietetics, V Edition, New Age International (P) Ltd, Publ

**Reference Books**

1. Passmore R. & Eastwood M.A (1986). "Human Nutrition and Dietetics", English language book Society/Churchill Livingstone, Eighth edition, Hong Kong.
2. Neiman N. Catherine (1990). "Nutrition" Wm. C. Brown Publishers. USA.
3. Mahan, L.K. and Escott-Stump, S (2000). Krause's Food, Nutrition and Diet Therapy, 10th Ed. W.B. Saunders Company, London.
4. Williams S.R (1993). Nutrition and Diet Therapy, 7th Ed. Times Mirror / Mosby College Publishing, St. Louis.
5. Antia F.P, & Philip (2002). Abraham Clinical Dietetics and Nutrition, Oxford University Press.
6. Shills, M.E, Oslon, J.A, Shike, M and Ross, A.C (1999). Modern Nutrition in Health and Disease.

### Web Resources/ E-Learning Resources

1. [https://med.libretexts.org/Courses/Dominican\\_University/DU\\_Bio\\_1550%3A\\_Nutrition\\_\(LoPresto\)/1%3A\\_Basic\\_Concepts\\_in\\_Nutrition/1.1%3A\\_Introduction\\_to\\_Nutrition](https://med.libretexts.org/Courses/Dominican_University/DU_Bio_1550%3A_Nutrition_(LoPresto)/1%3A_Basic_Concepts_in_Nutrition/1.1%3A_Introduction_to_Nutrition)
2. <https://pressbooks.bccampus.ca/nutr1100/chapter/introduction-2/>
3. <https://www.pw.live/chapter-food-where-does-it-come-from/classification-of-food>
4. <https://www.bethaniyaclinic.com/blog/diet-nutrition-and-disease-management/>
5. <https://nutritionalassessment.org/>

### CO – PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	2	1	3	3	2	1	2
CO 2	3	2	3	1	2	3	3	2	1	2
CO 3	3	2	2	1	2	3	3	2	1	2
CO 4	3	2	2	2	1	3	3	2	1	2
CO 5	3	2	2	1	1	3	3	2	6	2
Average	3	22	2.4	1.4	1.4	3	3	2	1	2

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4402	Animal Physiology	Core	5	4

This course deals with principles and basic facts of Animal Physiology. It also emphasizes on mammalian physiology and other vertebrate taxa. It deals with diverse functions of the living organisms encompassing digestive, respiratory, cardiovascular, muscular, nervous, renal and endocrine physiology.

**Course Outcomes:**

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

**CO1:** Compare digestive and respiratory systems of animals and infer mechanism of digestion and respiration.

**CO2:** Explain the functions of circulatory and excretory systems of animals.

**CO3:** Assess the relationship between nervous system and muscle contraction.

**CO4:** Evaluate the principles of endocrinology and sensory physiology.

**CO5:** Analyze the relationship between environment and physiological adaptations.

**UNIT I: (15 Hours)**

**Digestion and Respiration:** Digestive function - assimilation & absorption, unique food and feeding mechanisms in animals - BMR. Mechanism of respiration - respiratory pigments - transport of respiratory gases in the blood - air breathing in fishes - hypoxia - oxygen therapy - control of respiration - Neural and chemical regulation of respiration.

**UNIT II: (15 Hours)**

**Circulation and Excretion:** General pattern and principles of vertebrate circulation - blood coagulation - ECG - its principle and significance - cardiac cycle - control of heart beat and circulation. Kidneys of vertebrates - body fluids - nitrogen excretion - physiology of urine formation - renal clearance - regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance

**UNIT III: (15 Hours)**

**Muscle, Nerve cell and Signals:** Structure of muscle cell - sliding filament theory - cross - bridge function and production of force - role of calcium - electrochemical

coupling - neural control of muscle contraction. Components of nervous system - functional morphology of synapse, Impulse - types and transmission, Chemical transmitters - excitation, inhibition and computation.

**UNIT IV: (15 Hours)**

**Endocrine and sensory physiology:** Endocrine systems in vertebrates - Endocrine function - hormones - target tissues - mechanism of hormone action - hormonal control on reproduction – Hormones and diseases - Sensory qualities - principles - receptors - Sense organs: Vision, hearing and tactile response.

**UNIT V: (15 Hours)**

**Environmental Physiology:** Adaptation to the environment - Effect of high altitude - Problems of diving - Thermoregulation: Comfort zone, body temperature- physical, chemical, neural regulation, acclimatization -Osmo-iono regulation. Stress and adaptation

**Learning Resources:**

**Text Books**

1. Vander AJ, Sherman JH and Luciano DS (2001). Human Physiology: The Mechanism of Body Function, Eighth edn, McGraw Hill Inc. New Delhi.
2. Hall JE (2015). Guyton and Hall textbook of medical physiology, Thirteenth edn, Saunders (Elsevier), Canada.
3. Randall, D., W. Burggren, K. French and R. Eckert (2001). Animal Physiology Mechanisms and Adaptations, New York: W.H. Freeman and Co.

**References**

1. Ahearn, G.A. *et al.*, (1988). Advances in Comparative and Environmental Physiology – 2, Springer Publishers.
2. Gorden, M.S. *et al.*, (1977). Animal Physiology: Principles and Adaptation, New York, Third Edition.
3. Mcfarl D (1999). Animal Behaviour: Psychobiology, Ethology and Evolution, Longman Publisher.
4. Shepherd, G. M (1994). Neurobiology, OUP USA Publisher.

5. Withers, P.C (1992). Comparative Animal Physiology, Brooks/Cole Publisher.
6. Prosser C. L (1991). Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley-Liss Publishers.

### Websites/ e-Learning Resources

1. [https://swayam.gov.in/nd1\\_noc20\\_bt42/preview](https://swayam.gov.in/nd1_noc20_bt42/preview)
2. <https://www.classcentral.com/course/swayam-animal-physiology-12894>
3. [https://swayam.gov.in/nd1\\_noc20\\_hs33/preview](https://swayam.gov.in/nd1_noc20_hs33/preview)
4. <https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/animal-physiology>
5. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/animal-physiology>
6. <https://www.sciencedirect.com/book/9780080273419/advances-in-animal-and-comparative-physiology>
7. <https://www.sciencedirect.com/book/9780323552271/cunninghams-textbook-of-veterinary-physiology>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	1	3	1	2	1	2
CO2	3	2	2	2	2	2	1	2	1	2
CO3	3	2	2	2	2	2	1	2	1	2
CO4	3	2	2	2	1	2	1	2	1	1
CO5	3	2	2	2	1	2	1	2	1	1
Average	3	2.8	2	2	1.4	2.2	1	2	1	1.6

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4404	Genetics	Core	5	4

This course enable the students to understand the basic principles of genetics and important components of classical, microbial and population genetics. It also helps to study the Mendelian concepts and the history of genetics. It gives an overall view of genetic map and linkage. The human genetics study involves karyotyping and pedigree analysis.

**Course Outcomes:**

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

**CO1:** Identify Mendelian principles and theories of heredity.

**CO2:** Explain the mechanisms and importance of linkage and crossing over.

**CO3:** Analyze the mechanisms of microbial genetics.

**CO4:** Discuss the importance of Hardy-Weinberg equilibrium and factors affecting it.

**CO5:** Apply the concepts related to human genetics.

**UNIT I: (15 Hours)**

**Mendelian principles and chromosomal basis of inheritance :** Study of heredity, testing genetic hypotheses, multiple alleles, gene interactions, chromosome theory of heredity, extra nuclear inheritance, sex chromosome & sex determination, sex linked, sex influenced genes, rearrangement of chromosome structure and dosage compensation.

**UNIT II: (15 Hours)**

**Linkage, crossing over and chromosome mapping:** Linkage - types - an exception to Mendel's principle of independent assortment, crossing over as physical basis of recombination, chromosome mapping using recombination frequency - problems, linkage maps using ordered tetrad data.

**UNIT III: (15 Hours)**

**Microbial genetics:** Mechanisms of genetic exchange in bacteria through transformation, conjugation and transduction - use of partial diploids to map closely

linked genes. Bacteriophage T4 and lambda, rII locus of bacteriophage T4, evolution of the concept of gene as a unit of structure, function, and complementation test as an operational definition of the gene.

**UNIT IV: (15 Hours)**

**Quantitative and population genetics:** Genetic analysis of quantitative traits, polygenic inheritance, Hardy-Weinberg equilibrium - problems, estimating allele frequencies, factors affecting, inbreeding and out breeding.

**UNIT V: (15 Hours)**

**Human Genetics:** Human karyotype, banding techniques, genetic traits and inborn errors in man. Epigenetics and Human diseases. Variations in chromosome number - Genetics of human behavioural traits. Twin studies - Amniocentesis -Pedigree analysis - symbols - sex linked and autosomal pedigree - Gene bank. Eugenics, Euthenics and genetic counselling.

**Learning Resources:**

**Text Book**

1. Snustad DP and Simmons MJ (2010). Principles of Genetics, Fifth edn, John Wiley & Sons, Inc, New York.

**References**

1. Brooker RJ (2005). Genetics- Analysis and Principles, Second edn, McGraw-Hill Book Company, Boston, USA.
2. Hartl DL and Jones WJ (2005). Genetics - Analysis of Genes & Genomes, Sixth edn, Jones & Barlett Publishers, Massachusetts.
3. Hexter W and Yost HT (1977). The Science of Genetics, Prentice Hall of India Private Ltd., New Delhi.
4. Levine L (1969). Biology of the Gene. The CV Mosby Company, St. Louis, USA
5. Roth Well NV (1977). Understanding Genetics, Second edn, Oxford University Press, London.

**Websites/ e-Learning Resources:**

1. <https://www.khanacademy.org/science/ap-biology/heredity/mendelian-genetics-ap/a/the-law-of-segregation>
2. <https://microbeonline.com/key-information-regarding-gene-transfer-mechanism-bacteria>
3. <https://www.genome.gov>
4. <https://www.yourgenome.org>

**CO – PSO Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	1	2	3	2	2	2	1
CO2	3	2	2	2	2	3	2	2	2	1
CO3	3	3	3	3	2	3	2	2	2	1
CO4	3	2	2	2	2	3	2	2	2	1
CO5	3	3	3	2	2	3	2	2	2	1
Average	3	2.6	2.6	2	2	3	2	2	2	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4502	Molecular Biology	Core	6	5

This course emphasizes the molecular basis of life. It deals mainly with nucleic acids, proteins and their interactions. It covers the detailed molecular mechanisms involved in DNA replication, recombination, transcription, translation and transposition. A special emphasize is given to post- transcriptional and -translational modifications. It also includes an in depth study on mutations, DNA damage and repair mechanisms. Current understanding on the gene regulatory mechanisms is also focused.

### Course Outcomes:

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

**CO1:** Analyze the topology, structure and properties of nucleic acids.

**CO2:** Discuss the events involved in replication, recombination and transposition.

**CO3:** Describe the different stages of transcription in prokaryotes and eukaryotes.

**CO4:** Examine the process involved in translation and gene regulation.

**CO5:** Evaluate the types of DNA damage, mutation and DNA repair pathways.

### UNIT I: (18 Hours)

**Structure and properties of nucleic acids:** Properties and functions of genetic materials: DNA as the genetic material - Basic structure of DNA and RNA, alternate and unusual forms of DNA - Physical and Chemical properties of nucleic acid- base properties, denaturation and renaturation-  $T_m$  and  $cot$  values- hybridization-C Value paradox.

### UNIT II: (18 Hours)

**Replication, recombination and transposition:** mechanisms of replication-Semi conservative, rolling and D-loop models of replication- Homologous and site specific recombination- Transposable elements - Tn3, Tn5, Tn10, *Mu* phage, LINES, SINES-significance and mechanism of transposition.

**UNIT III: (18 Hours)**

**Transcription in prokaryotes and eukaryotes:** Structure and types of RNA - RNA polymerases - stages of transcription - transcriptional factors - Post transcriptional modifications - RNA processing -capping, splicing, polyadenylation and RNA editing.

**UNIT IV: (18 Hours)**

**Translation in prokaryotes and eukaryotes and gene regulation:** code - properties-deciphering and exceptions to universality - stages of translation - translation factors -aminoacylation of tRNA - aminoacyl tRNA synthetase - translational proofreading - translational inhibitors - Post translational modifications of proteins- gene regulation - Operon concept- lactose and galactose metabolism - Gene Silencing- Histone modification- chromatin remodelling- DNA methylation- RNA interference.

**UNIT V: (18 Hours)**

**Mutation, DNA damage and repair:** Mutations - Spontaneous and induced mutations- Physical and chemical mutagenesis- DNA damage- causes &types - DNA repair mechanisms- Mismatch repair, Base excision repair and Nucleotide excision repair.

**Learning Resources:**

**Text Books**

1. Malacinski GM (2003). Freidfelder's Essentials of Molecular Biology. IV Edition, Narosa Publishing House, New Delhi, India.
2. Watson J.D., N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner (2007). Molecular Biology of the Gene, 6th Edition, Benjamin Cummings Publishing Company Inc.

**References**

1. Alberts, B., A. Johnson, J. Lewis, *et al.*, (2015). Molecular Biology of the Cell (Sixth Edition), Garland Science, New York.

- Brown TA (2007). Genomes 3. III Edition, Garland Science Publishing, New York.
- De Robertis EDP and De Robertis EMF (2010). Cell and Molecular Biology, 8<sup>th</sup> edition, BI Waverly Pvt.Ltd, New Delhi.
- Krebs JE, Goldstein ES and Kilpatrick ST (2014). Lewin's Genes XI, Jones and Barlett learning, Burlington, MA.
- Lodish H, Berk A, Kaiser CA, Krieger M, Bretscher A, Ploegh H, Martin KC, Yaffe M, Amon A (2021). Molecular cell biology, 9<sup>th</sup> edition, Macmillan learning.
- Loewy, A.G., P. Siekevitz and J. R. Menninger, *et al.*, (1991). Cell Structure and Function 3<sup>rd</sup> edition Saunders, Philadelphia.
- Watson JD, Baker TA, Bell SP, Alexander G and Levine M (2013). Molecular Biology of the Gene, 7<sup>th</sup> edition, Benjamin-Cummings Pub Co., San Francisco, USA.

#### Websites/ e-Learning Resources

- <https://www.youtube.com/watch?v=gG7uCskUOrA>
- <https://www.youtube.com/watch?v=K53EOjjMt4E>
- <https://www.youtube.com/watch?v=GdF7BX58H4I>

#### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	3	3	2	2	2	1
CO 2	3	3	3	3	2	3	2	2	2	1
CO 3	3	3	3	3	2	3	2	2	2	1
CO 4	3	3	3	3	3	3	2	2	2	1
CO 5	3	3	3	3	3	3	2	2	2	1
Average	3	3	3	3	2.6	3	2	2	2	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

<b>Course Code</b>	<b>Name of the Course</b>	<b>Category</b>	<b>Hours/Wk.</b>	<b>Credits</b>
24PGZ4302	Animal Physiology and Molecular Biology Lab	Core	5	3

Animal Physiology part of the laboratory course deals with exercises on digestion, osmo-iono regulation, thermoregulation, nitrogen excretion, respiration, circulation and chronobiology. Molecular Biology part of the laboratory course deals with basic molecular biology laboratory exercises such as isolation of DNA and RNA from eukaryotic cells, and plasmids from bacteria. Experiments using *E. coli* such as mutagenesis, transformation, conjugation will also be carried out.

#### **Course Outcomes:**

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

**CO1:** Evaluate factors influencing physiological activity.

**CO2:** Analyze the constituents of blood.

**CO3:** Demonstrate the process of excretion and osmoregulation in animals.

**CO4:** Apply molecular biology experiments and solve problems.

**CO5:** Recent facilities are available in other research institutes.

### **I. Lab in Animal Physiology**

#### **Laboratory Exercises:**

1. Plasticity of pulse rate and heart beat
2. Analysis of human blood - total and differential count of RBC, WBC
3. Estimation of oxygen consumption under stress
4. Determination of Q10 in fish
5. Osmoregulation in fishes.
6. Experiments on sensory organs - vision, hearing and taste
7. Effect of insulin level on vertebrate blood glucose
8. Qualitative analysis of excretory products
9. Factors affecting salivary amylase activity

## **II. Lab in Molecular Biology**

### **Laboratory Exercises:**

1. Isolation of genomic DNA from bacteria
2. RNA extraction from chick liver
3. Isolation of DNA from grasshopper
4. Agarose gel electrophoresis of DNA
5. Mutagenesis using chemical mutagens
6. Physical mutagenesis (UV-induced)
7. Bacterial transformation
8. Bacterial Conjugation
9. SDS-Polyacrylamide gel electrophoresis
10. Visit to research laboratories.

### **Learning Resources:**

#### **References**

1. Amrit K (2006). Laboratory manual of animal physiology and Biochemistry, First edn, CBS Publishers & Distributors Pvt. Ltd, New Delhi.
2. Durairaj G (1987). Animal physiology - A laboratory manual, COSIP-ULP Publications, Dept. of Zoology, University of Madras, Chennai.
3. Rajamanickam C (2000). Laboratory Protocols in Molecular biology and Biochemistry. Osho Science Publishers, Madurai.
4. Dantzler, W.H (1997). Comparative Physiology (Handbook of Physiology), Volumes I and II. Edited by William H. Dantzler. Published for the American Physiological Society by Oxford University Press Inc., New York. Oxford University Press Canada, Toronto.
5. Sambrook J and Russell DW (2001). Molecular cloning: A Laboratory Manual. Third edn, Cold Spring Harbor Press, New York.

#### **Websites/ e-Learning Resources**

1. <https://www.labster.com/course-packages/animal-physiology>
2. <https://www.ncbi.nlm.nih.gov/books/NBK261/>
3. <https://link.springer.com/article/10.1007/s11160-019-09553-3>

4. [https://www.researchgate.net/publication/330595598\\_Thermal\\_Tolerances\\_of\\_Freshwater\\_Mussels\\_and\\_their\\_Host\\_Fishes\\_Species\\_Interactions\\_in\\_a\\_Changing\\_Climate](https://www.researchgate.net/publication/330595598_Thermal_Tolerances_of_Freshwater_Mussels_and_their_Host_Fishes_Species_Interactions_in_a_Changing_Climate)
5. <https://onlinelibrary.wiley.com/doi/10.1002/9780470015902.a0029291#:~:text=Osmoregulation%20involves%20the%20maintenance%20of,one%2Dthird%20that%20of%20seawater.>
6. <https://www.sciencedirect.com/science/article/abs/pii/S0300962977902675>
7. <https://amrita.olabs.edu.in/?brch=18&cnt=1&sim=236&sub=79#:~:text=Effect%20of%20Temperature&text=Optimum%20temperature%20for%20the%20enzymatic,time%20to%20digest%20the%20starch.>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	1	3	3	1
CO2	3	3	3	3	3	3	2	3	3	1
CO3	3	3	2	1	3	3	2	3	3	1
CO4	3	3	3	2	3	3	3	2	3	1
CO5	3	3	2	1	3	3	3	2	3	1
Average	3	3	2.6	2	3	3	2.2	2.6	3	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

<b>Course Code</b>	<b>Name of the Course</b>	<b>Category</b>	<b>Hours/Wk.</b>	<b>Credits</b>
24PGZ4406	Biostatistics and Research Methodology	DSE	5	3

This course is designed to impart fundamental knowledge on sources & acquisition, organization & presentation of data. It targets at teaching certain important biostatistical analyses such as measures of central tendencies, dispersion of data and tests of significance. It also gives an introduction to the usage of PAST package in biostatistical analysis. Second part of the course deals with the basics of research and the research process, provides an introduction to research methods and report writing and gives insight into various kinds of research design and sampling.

**Course Outcomes:**

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

**CO1:** Identify the sources and methods of data collection, classification and presentation.

**CO2:** Compute the central tendencies, measures of dispersion, standard deviation & error, linear regression and simple correlation.

**CO3:** Analyse the significance, goodness of fit, variance & statistical packages.

**CO4:** Evaluate the objectives, types and significance of research.

**CO5:** Investigate the ethical aspects of research and evaluate the different methods of scientific writing and reporting.

**UNIT I: (15 Hours)**

**Collection and Presentation of Data:** Biostatistics- introduction, definition, basic concepts, terminologies. Data - types and sources, collection methods, sampling – random & non-random, classification of data - Sturge’s rule .Presentation of data - tabulation, graphical and diagrammatic representation.

**UNIT II: (15 Hours)**

**Descriptive statistics:** Measures of central tendency-arithmetic mean, median and mode. Measures of dispersion - standard deviation and Standard error - linear regression and correlation coefficient.

**UNIT III: (15 Hours)**

**Tests of significance:** Students t-test (simple, paired), F-test - chi-square ( $\chi^2$ ) test - Analysis of Variance (ANOVA). Introduction to statistical software – MS-Excel, PAST, Graphic & diagrammatic representations -Elements of Probit analysis.

**UNIT IV: (15 Hours)**

**Research Concepts:** Concept, Objectives, Types of Research, Research Approaches - Significance of Research- Research and Scientific Method - Researching a scientific problem; defining aims & objectives ,Essential features of abstract, introduction, review of literature, materials and methods, results, summary, discussion and bibliography. Effective illustration of data. Reference styles: Harvard and Vancouver Systems, MLA & APA- LaTeX.

**UNIT V: (15 Hours)**

**Ethics and Art of Scientific Writing:** Proposal Writing-Authors, acknowledgements, reproducibility, Numbers, units, abbreviations and nomenclature used in scientific writing authorship issues; IPR, Scientific ethics – Plagiarism, Plagiarism Tools: Turnitin, Ithenticate, & Urkund. Bibliographic index and research quality parameters. Citation Tools: Easy Lib, Biblio, Endnote and Citation. Data Bases: Web of Science and Scopus, impact factor, h-index and i10 index.

**Learning Resources:**

**Text Books**

1. Gurumani N (2006). Research Methodology: For Biological Sciences, MJP Publishers
2. Kothari C R and Gaurav Garg (2019). Research Methodology: Methods and Techniques Fourth (Multi Colour) Edition, New Age International Publishers.
3. Rastogi VB (2015). Biostatistics, Third edn, Medtech publishers NewDelhi.

**References**

1. Landaus Landaus and Everitt B.S (2003). A Handbook of Statistical analyses using SPSS, Chapman & Hall/CRC Press, London.

2. Le C.T and Eberly L.E (2016). Introductory Biostatistics, Second edn, John Wiley and Sons, New Jersey.
3. Wayne C. Booth, Gregory Colomb, Joseph M. Williams, William Fitzgerald (2016). Craft of Research, 4<sup>th</sup>edition, University of Chicago Press.
4. Stanton G.A (2002). Primer of Biostatistics, Fifth edn, McGraw-Hill, New York.
5. Zar J.H (2005). Biostatistical Analysis, Fourth edn, Pearson Education Inc., NewDelhi.

**Websites/ e-Learning Resources:**

1. <https://www.simplilearn.com/what-is-data-collection-article>
2. <https://statistics.laerd.com/statistical-guides/measures-central-tendency-mean-mode-median.php>
3. <https://www.analyticsvidhya.com/blog/2018/01/anova-analysis-of-variance>
4. <https://www.indeed.com/career-advice/career-development/types-of-research>

**CO – PSO Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	3	3	3	3	3	3	3	1
CO 2	3	3	3	2	3	3	3	2	3	1
CO 3	3	2	3	2	3	3	2	2	3	1
CO 4	3	3	3	3	3	3	2	3	3	1
CO 5	3	3	3	3	3	3	3	2	3	1
Average	3	2.8	3	2.8	3	3	2.6	2.4	3	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4408	Aquaculture	DSE	5	4

Aquaculture is the science and business of cultivating marine and freshwater organisms. This course emphasizes the scientific knowledge and methods necessary for aquaculture. Students learn the scope, culture techniques, scientific marketing, and general management practices.

### Course Outcomes

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

**CO1:** Develop comprehensive knowledge in the discipline of Fishery Science and Aquaculture.

**CO2:** Analyse the Hatchery Management, breeding techniques and fish feed management.

**CO3:** Apply various culture methods for Indian Major carps, prawn, and oyster.

**CO4:** Identify the various diseases, causative agents and control measures in fish.

**CO5:** Explain the culture methods of ornamental fishes and the activities of central aquaculture organizations.

### UNIT I: (15 Hours)

**Introduction to aquaculture:** Importance of aquaculture- Present status, prospects and scope in India. Freshwater aquaculture- Brackish water aquaculture- Mariculture - Metahaline culture in India. Types of fish culture -Types of fish ponds. Topography, site selection - water quality - soil condition and quality – structure and construction design and layout. Water quality management for aquaculture. Control of parasites, predators and weeds in culture ponds. Fish farm implements - Secchi disc - aerator - pH meter - tools for hypophysation - feeding trays – Fishing gears used in aqua farming.

### UNIT II: (15 Hours)

**Breeding and hatchery technology:** Procurement of seed from natural resources- collection methods and segregation. Hatchery technology for major carps and freshwater prawn. Artificial seed production –Breeding under control conditions, induced breeding technique, larval rearing, packing and transportation. Classification

of fish feed- Artificial feeds Types, Feed - formulation - feeding methods. Live feed- Microalgae, Rotifer, Artemia and their culture.

**UNIT III: (15 Hours)**

**Aquatic organisms and culture techniques:** Shrimp hatchery technology - Hatchery design - brood stock management – spawning - larval rearing - Shrimp developmental stages, algal culture, packing and transportation. Shrimp culture technology – extensive, semi- intensive - intensive culture methods. Biofloc technology - culture operations (water quality, feed and health management) - harvesting, preservation and marketing. Brackish water fish culture. Edible and Pearl oyster culture - pearl production. crab culture. Economic importance of Lobster, Sea urchin and Sea cucumber. Seaweeds - by-products – economic importance.

**UNIT IV: (15 Hours)**

**Diseases and health management:** Fish disease- infectious – Bacterial (Fin and tail rot), Fungal (Water mould) - Viral (Viral haemorrhagic septicemia) - Parasitic (Knot disease) and non-infectious - nutritional deficiency diseases (Scoliosis) - Diagnosis – prevention – control measures.

**UNIT V: (15 Hours)**

**Ornamental fish culture & Research Organizations:** Types - freshwater (Gold fish) -marine (clown fish) - breeding behaviour - biology. Oviparous - Ovo-viviparous -Viviparous fishes. Setting and maintenance of freshwater Aquarium tanks. Central aquaculture research organizations - CMFRI, CIBA, CIFT, CIFA, CIFE, MPEDA and its activities.

**Learning Resources:**

**Text Books**

1. Pillay, T. V. R (1990). Aquaculture: Principles and Practices. Blackwell Scientific Publications Ltd.
2. Santhanam, R (1990). Fisheries Science. Daya Publishing House.

## References

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

## Websites/ e-Learning Resources

1. <https://adpcollege.ac.in/online/attendance/classnotes/files/1626415871.pdf>
2. <https://openknowledge.fao.org/server/api/core/bitstreams/cb1aac0d-def6-4e18-bef3-8b45f37e3aaf/content>
3. <https://empangqq.wordpress.com/wp-content/uploads/2017/04/fish-hatchery-management.pdf>

## CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	1.5	3	2	2	1	3	3	3	3
CO2	3	3	3	3	3	2	3	3	3	3
CO3	3	3	3	3	3	1	3	3	3	3
CO4	3	1.5	3	3	1	1	3	3	3	3
CO5	3	3	3	2	3	2	3	3	3	2
Average	3	2.4	3	2.6	2.4	1.4	3	3	3	2.8

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4304	Poultry Farming	GE	4	3

This course aims to develop human resource in the area of poultry farming. It will impart knowledge in poultry industry, farming, breeding, housing, nutrition, disease and management. This course will also help to understand the various aspects of poultry rearing.

### Course Outcomes

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

**CO1:** Discuss the aspects of poultry industry, biology of fowl and nutrition.

**CO2:** Identify the Indian exotic breeds, importance of layers and broilers and to evaluate their efficiency.

**CO3:** Apply the poultry equipment for day-to-day activities to be involved in the farm, explain the rearing system, and use them efficiently.

**CO4:** Compare the source of ingredients for the poultry feed stuff and formulate homemade feed for broilers and layers, feed additives and summer and winter management.

**CO5:** Analyze the nature and control of bacterial, fungal, viral and parasitic infections.

### UNIT I: (12 Hours)

**Poultry industry & biology:** History of poultry industry in India - 5 year plans - NECC - entrepreneurship - funding agencies - role of egg and meat in human nutrition - poultry manure and byproducts. External features - digestive and reproductive systems - egg formation - feather sexing - feather tracts.

### UNIT II: (12 Hours)

**Breeds of layers and broilers:** Classification - Indian and exotic breeds - production of commercial laying stock - cross breeds - sexing in one day old chicks - popular breeds of layers and broilers in India.

**UNIT III: (12 Hours)**

**Housing and Equipment:** Location of the farm – construction of poultry sheds – layout of broiler and layer farms – 1+3 housing system, all in and all out system – deep litter system – cage rearing - incubator – waterer – feeder – nest box – brooder – dropping pit – disposal pit.

**UNIT IV: (12 Hours)**

**Nutrition and Management:** Energy – carbohydrates – fats – proteins – vitamins – minerals – feed stuff – feed formulation – non-nutritive feed additives – feed grinder – home made mineral mixture of feed for chick – grower – layer – broiler and finisher – Incubation – management of growers – layers – summer and winter management – forced moulting - debeaking – culling – marketing.

**UNIT V: (12 Hours)**

**Diseases and control measures:** Bacterial (*Infectious coryza*), viral (Newcastle, bird flu), fungal (*Mycotoxicosis*) and parasitic (*Coccidiosis*) – transmission, symptoms & treatment. Vaccination - antibiotics - nutritional deficiencies.

**Learning Resources:**

**Text Book**

1. Gnanamani M.R (2003). Modern Aspects of Commercial Poultry Keeping, Ninth edn, Giri Publications, Madurai.

**References**

1. Chauhan HVS and Roy S (2007). Poultry Diseases, Diagnosis and Treatment, Third edn, New Age International, New Delhi.
2. Jaiswal V and Jaiswal KK (2014). Economic Zoology, PHI Learning Private Limited, New Delhi.
3. Jull MA (1976). Poultry Husbandry, Third edn, Tata McGraw Hill Publishing Company Ltd. New Delhi.

**Web Resources/ E-Learning Resources**

1. <https://www.aakash.ac.in/important-concepts/biology/poultry-farming>

2. [http://www.agritech.tnau.ac.in/animal\\_husbandry/ani\\_chik\\_breeds%20of%20chicken.html](http://www.agritech.tnau.ac.in/animal_husbandry/ani_chik_breeds%20of%20chicken.html)
3. <https://vikaspedia.in/agriculture/poultry/breeds-of-poultry>
4. <https://www.inpoultry.com/module-3-national-poultry-improvement-plan-rules-and-forms>

### **CO – PO Mapping**

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10
CO 1	3	3	3	3	3	3	3	3	3	3
CO 2	3	3	3	3	2	3	3	3	3	3
CO 3	3	3	3	3	2	3	3	3	3	3
CO 4	3	3	3	3	2	3	3	3	3	3
CO 5	3	3	3	3	2	3	3	3	3	3
Average	3	3	3	3	2.2	3	3	3	3	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ4306	Introduction to Ornithology	GE	4	3

The course aims to give knowledge on the classification of birds, flight adaptation, migration, and conservation of birds. It also inculcates knowledge on birds of India and birds census using gadgets.

### Course Outcomes

At the end of this course, students will be able to:

**CO1:** Examine the diversity of birds and their biology.

**CO2:** Explain the birds' adaptation to different habitats.

**CO3:** Evaluate the history of birds in India and their habitats.

**CO4:** Describe the migration of birds and its conservation strategies.

**CO5:** Demonstrate the document birds using different gadgets.

### UNIT I: (12 Hours)

**Classification of Birds & Biology:** Classification-General characters - Characters of Archaeopteryx - adaptive radiation of beaks and feet – features of Ratitae- Roosting and communal display-Nesting and Parental care- Food and feeding behavior.

### UNIT II: (12 Hours)

**Flight Adaptation and types of birds:** Morphological, Anatomical and physiological adaptations- Biogeographic patterns in Indian avifauna- Montane avifauna, Aerial, terrestrial and arboreal birds. Birds in Agriculture - beneficial and harmful - Economic importance.

### UNIT III: (12 Hours)

**Birds of India:** History of Ornithology in India – Birds in Mythology, folklore and Indian culture – Bird man of India - Bird diversity hotspots in India - Grassland, Desert, Wetland, forest, Island, Shore & Himalayan birds

**UNIT IV: (12 Hours)**

**Migration and Conservation of birds:** Migration - Types, Modes, Problems, Advantages and Disadvantages. Extinct, endangered and threatened birds of India and their conservation. Bird Sanctuaries, Birds as state symbol, declining of bird species- vultures and sparrows.

**UNIT V: (12 Hours)**

**Field Ornithology:** Bird census techniques – Equipment – Field kit – Bird – Ringing - ring recovery – Radio telemetry – RFID, GPS, Camcorder, CCTV camera, night vision scope on, GBBC, eBird data- Application and use.

**Learning Resources:**

**Text Books**

1. Ali, S (2002). The Book of Indian Birds. Bombay Natural History Society, Mumbai, India.
2. Jordan EL and Verma P.S (2013). Chordate Zoology, S.Chand & Co Ltd., New Delhi.

**References**

1. Ali S and Ripley, SD (2002). Handbook of the Birds of India and Pakistan. Vol 1-10, 2<sup>nd</sup> Edition, Oxford University Press, India.
2. Grimmett R, Inskipp C and Inskipp, T (2012). Pocket Guide to the Birds of the Indian Subcontinent (Helm Field Guides). 2<sup>nd</sup> Edition. Christopher Helm Publishing Company Ltd., UK.
3. Kazmierczak K and Van Perlo BA (2000). Field Guide to the Birds of the Indian Subcontinent. Yale University Press, New Haven.

**Web Resources/ E-Learning Resources**

1. <https://stateofindiasbirds.in/>
2. Cornell Lab All about Birds - <https://www.allaboutbirds.org/guide/>
3. [https://stateofindiasbirds.in/wp-content/uploads/SoIB-2023\\_report.pdf](https://stateofindiasbirds.in/wp-content/uploads/SoIB-2023_report.pdf)
4. <https://ebird.org/india/home>

### CO – PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	1	1	2	3	3	3	3	3
CO 2	3	3	1	1	2	3	3	3	3	3
CO 3	3	3	1	1	3	3	3	3	3	3
CO 4	3	3	1	1	3	3	3	3	3	3
CO 5	3	3	1	1	3	3	3	3	3	3
Average	3	3	1	1	2.6	3	3	3	3	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5501	Entomology	Core	6	5

This course is designed to understand the structure and functional aspects of insects and their economic importance. This course covers the four major aspects: insect taxonomy, functional morphology, impact of insects in human welfare and pest control measures.

### Course Outcomes

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

**CO1:** Compare the external morphological features of insects.

**CO2:** Describe the different orders of insects with taxonomy.

**CO3:** Discuss the function of organ systems in insects.

**CO4:** Explain the role of the beneficial and harmful aspects of insects.

**CO5:** Assess the importance of integrated pest management and insecticides.

### UNIT I: (18 Hours)

**Insect body Plan:** External morphology - head, sutures, photoreceptor, antennae, mouth parts - Thorax - tergum - sternum - pleuron - leg & wing modifications - coupling mechanisms - abdomen - modification - genital structures - Insects as most successful group of organisms.

### UNIT II: (18 Hours)

**Insect taxonomy:** Apterygota - Protura - Diplura - Archaeognatha - Thysanura. Exopterygota - Paleopterous - Neopterous. Endopterygota - Coleopterous - Neopterous - Hymenopterous insects.

### UNIT III: (18 Hours)

**Organ systems:** Digestive system - glands - digestion. Excretory system - malpighian tubules - mechanism. Circulatory system - pumping organs - mechanism - haemolymph - haemocytes - functions. Respiratory system - structure - aquatic respiration - respiration of endoparasitic insects. Endocrine glands - corpora cardiaca - corpora allata - thoracic glands - molting - functions.

**UNIT IV: (18 Hours)**

**Insects of economic importance:** Insect pests - 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 (*Leptocorisa acuta*, *Scirpophaga incertulas*), cotton (*Aphis gossypi*, *Dysdercus cingulatus*), sugarcane (*Scirpophaga nivella*, *Emmalocera depressella*), coconut (*Oryctes rhinoceros*, *Rhynchophorus ferrugineus*) and stored grains cereals (*Rhizopertha dominica*, *Orzaephilus surinamensis*). Beneficial insects - honey bee - diversity, structural adaptations, colony and management. Sericulture - moriculture - diversity - life cycle - rearing – grainage - diseases. Lac insects-life history, lac cultivation.

**UNIT V: (18 Hours)**

**Pest control and integrated pest management:** Vector biology: Vectors of veterinary and public health importance - Mosquitoes as potential vectors of human diseases-control- lice, bed bugs, and housefly - vector status and control – biological control - Pest management - IGR (Insect Growth Regulator) - synthetic hormones – pheromones allelochemicals - genetic control - IPM (Integrated Pest Management) in paddy field.

**Learning Resources:**

**Text Book**

1. Ambrose DP (2004). The Insect Structure, Function and Biodiversity, Kalyani publications, New Delhi.

**References**

1. Chapman RF, Simpson SJ and Douglas AE (2013). The Insects: Structure and Function, Fifth edn, United States of America by Cambridge University Press, New York.
2. David BV and Ananthakrishnan TN (2004). General and Applied Entomology, Tata McGraw-Hill publishing Company Limited, New Delhi.
3. David BV and T Kumarasamy (1982). Elements of Economic Entomology, Popular Book Depot, London.

4. Richards OW and Davies RG (1977). Imm's General Textbook of Entomology, Vol-1 & 2, Tenth edn, BI Publications Pvt. Ltd, New Delhi.
5. Robert HR (1959). A Textbook of Entomology, Second edn, John Wiley & Sons Inc., New York.
6. Snodgrass RE (1935). Principles of Insect Morphology, McGraw Hill Book Company Inc., New York.
7. Fennemore PG and Alka Prakash (1992). Applied Entomology, Wiley Eastern Ltd, New Delhi.

### Websites/ e-Learning Resources

1. [https://extension.entm.purdue.edu/401Book/default.php?page=insect\\_anatomy#:~:text=The%20three%20main%20insect%20body,legs%20and%20wings%20are%20attached.](https://extension.entm.purdue.edu/401Book/default.php?page=insect_anatomy#:~:text=The%20three%20main%20insect%20body,legs%20and%20wings%20are%20attached.)
2. <https://www.royensoc.co.uk/understanding-insects/classification-of-insects/>
3. [https://en.wikipedia.org/wiki/Insect\\_physiology](https://en.wikipedia.org/wiki/Insect_physiology)
4. <https://microbenotes.com/economic-importance-beneficial-and-harmful-of-insects/>
5. <https://www.epa.gov/safepestcontrol/integrated-pest-management-ipm-principles>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	3	3	2	1	2	3	2
CO2	3	3	2	3	3	2	2	2	3	1
CO3	3	3	2	2	3	2	2	3	2	1
CO4	3	3	2	2	3	2	3	2	3	3
CO5	3	3	3	3	3	3	3	3	3	10
Average	3	3	2.2	2.6	3	2.2	2.2	2.4	2.8	2

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5401	Evolution	Core	5	4

This course provides an insight of human existence on earth. It includes origin of life, history of evolutionary thought, Darwinism & current challenges, molecular phylogeny and evolutionary clock, isolating mechanisms, speciation and transpacific evolution. It also deals with human evolution, phylogeny and cultural way of living.

### Course Outcomes

At the end of the course, students will be able to:

At the end of the course, students will be able to:

**CO1:** Discuss the concept of evolution and different theories for exploring the mechanism of evolution.

**CO2:** Analyze the origin of cell and unicellular eukaryotes.

**CO3:** Assess the major events in the evolutionary time scale; Origins of unicellular and multi-cellular organisms.

**CO4:** Discuss the origin of new genes and proteins; Gene duplication and divergence.

**CO5:** Explain the concepts and rate of change in gene frequency through natural selection, migration and gene frequency drift.

### UNIT I: (15 Hours)

**Emergence of evolutionary thoughts:** Lamarck and Darwin – concepts of variation, adaptation – struggle - fitness - natural selection – Mendelism - spontaneity of mutations - evolutionary synthesis.

### UNIT II: (15 Hours)

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

**UNIT III: (15 Hours)**

**Palaeontology and evolutionary history:** Evolutionary time scale – Eras - periods - epoch - Major events in the evolutionary time scale - Origins of unicellular and multi cellular organisms - Stages in primitive evolution including Homo sapiens.

**UNIT IV: (15 Hours)**

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

**UNIT V: (15 Hours)**

**Population genetics:** Populations - gene pool - gene frequency - Hardy-Weinberg Law - concepts and rate of change in gene frequency through natural selection, migration and random genetic drift - Adaptive radiation - isolating mechanisms – speciation - allopatricity and sympatricity - convergent evolution - sexual selection - co-evolution - Altruism and evolution.

**Learning Resources:**

**Text Books**

1. Dobzhansky T, Ayala FA, Stebbins GL and Valentine JW (2017). Evolution, Surjeet Publishers, New Delhi.
2. Strickberger MW, Hall BK and Hallgrimsson B (2007). Strickberger's Evolution, Fourth edn, Jones and Bartlett, Sudbury, MA, USA.

**References**

1. Kostas Kampourakis (2014). Understanding Evolution. Cambridge University Press.
2. John Maynard Smith (1993). The theory of evolution. Cambridge University Press
3. Dodson EO (1960). Evolution: Process and Product, Affiliated East-West Press, New Delhi.
4. Stebbins GL (1966). Process of organic evolution, Prentice Hall, New Delhi.

### Websites/ e-Learning Resources

1. [https://www.bionity.com/en/encyclopedia/History\\_of\\_evolutionary\\_thought.html](https://www.bionity.com/en/encyclopedia/History_of_evolutionary_thought.html)
2. <https://plato.stanford.edu/entries/darwinism/>
3. [https://evolutionnews.org/2012/07/what\\_are\\_the\\_to\\_1/](https://evolutionnews.org/2012/07/what_are_the_to_1/)

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	3	2	3	3	1
CO2	2	3	2	3	2	3	3	2	3	1
CO3	3	2	3	3	2	3	2	3	3	1
CO4	2	3	2	3	2	3	3	2	3	1
CO5	3	3	2	3	3	3	2	3	3	1
Average	2.6	2.8	2.4	3	2.2	3	2.4	2.6	3	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5503	Immunology	Core	6	5

This theory course provides a comprehensive coverage of the essential concepts and the current understanding of cellular and molecular events underlying immunity. This course on Immunology deals with types of immune response, organs of immune system, antigen, antibody – structure, diversity and antigen-antibody interactions. It also includes components of cellular & humoral immune system like major histocompatibility complex, cytokines and complement. Clinical aspects such as hypersensitivity reactions, autoimmunity, disorders of immune response, transplantation and tumour Immunology are also dealt.

### Course Outcomes

At the end of the course, students will be able to:

**CO1:** Explain the innate, adaptive immune responses and functions of immune tissues.

**CO2:** Analyze the nature of antigens and cell mediated immune effectors components.

**CO3:** Discuss the significance of antibodies, cytokines and interleukins.

**CO4:** Examine the hypersensitive, autoimmune and immunodeficiency disorders.

**CO5:** Assess the immune activation during transplantation and against tumour antigens.

### UNIT I:

**(15 Hours)**

**Introduction to Immunology:** An overview - scope of immunology - recognition of self and non-self as a basic functional feature of immune system. Concepts of external and internal defense systems - primary and secondary immune responses. Types of immunity - innate and acquired - types, functional features. Immune tissue – types - anatomical location - structure and development - lymphocyte traffic during development.

**UNIT II:****(15 Hours)**

**Antigens & Major effector components of cellular immune system:** Antigens - characteristic features and classification - Antigenicity - immunogenicity – Adjuvants - types and applications. Lymphocytes – types – morphology – clones - sub-populations – distribution - B and T cell receptors - B and T cell epitopes - Toll-like receptors. Antigen presenting cells - antigen processing and presentation - MHC molecules and their immunologic significance.

**UNIT III:****(15 Hours)**

**Major effector components of humoral immune system:** Antibodies - Primary structure, classification - Structural and functional characteristics of various antibody classes - Generation of diversity - Antigen-antibody interactions. Complement system – Components -three major activation pathways - immune functions. Cytokines - salient functional features; Interleukins - types –lymphokines, monokines, and functions. Interferons – origin, types and functions.

**UNIT IV:****(15 Hours)**

**Diseases and immune responses:** Hypersensitivity- Types I to IV and immune manifestations. Auto-immune diseases - major immune responses. Immunodeficiency diseases - types - SCID -consequences; Viral (HIV) – bacterial (tuberculosis) - parasitic (malaria) diseases – etiology - host immune responses and evasion by pathogens.

**UNIT V:****(15 Hours)**

**Transplantation and tumor immunology:** Immunologic basis of graft rejection - clinical manifestations of graft rejections - general and specific immunosuppressive therapy - clinical transplantation. Tumours - tumour antigens - immune response to tumours - tumour evasion of the immune system - cancer immunotherapy. Vaccines - types, preparations, efficacies and recent developments.

## **Learning Resources:**

### **Text Books**

1. Punt J, Stranford S, Jones P and Owen J (2018). Kuby Immunology, Eighth edn, W.H. Freeman and Co., New York
2. Delves PJ, Martin SJ, Burton DR and Roitt IM (2006). Essential Immunology, Eleventh edn, Blackwell Publishers Ltd, UK.
3. Abbas, A. K and A. H. Lichtman (2007). Cellular and Molecular Immunology (6th edition), W. B. Saunders, Philadelphia
4. Coico R and Sunshine G (2009). Immunology: A short course, Sixth edn, Wiley Blackwell, New York.

### **References**

1. Hood, L. Weissman, I. Wood, W. Wilson, J (1984). Immunology (Second Edition), the Benjamin/Cummings, California.
2. Doan, T. Melvold, R. Viselli, S. *et al.*, (2013). Immunology (Second Edition), Lippincott Williams & Wilkins, Maryland.
3. Khan FH (2009). The Elements of Immunology. First edn, Pearson Education, New Delhi.

### **Websites/ e-Learning Resources:**

1. <https://www.ibiology.org/educators-resources/flipped-courses/immunology-flipped-course/>
2. <https://www.niaid.nih.gov/research/immune-system-overview>
3. <https://www.inside-immunity.org/en.php>
4. <https://libguides.apsu.edu/c.php?g=933975&p=6732209>
5. [https://www.youtube.com/watch?v=\\_VhcZTGv0CU](https://www.youtube.com/watch?v=_VhcZTGv0CU)
6. [https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture\\_notes/med\\_lab\\_tech\\_students/LN\\_Imm\\_Serology\\_final.pdf](https://www.cartercenter.org/resources/pdfs/health/ephti/library/lecture_notes/med_lab_tech_students/LN_Imm_Serology_final.pdf)

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	2	3	3	2	2	1	3	3	1
CO2	3	2	3	3	2	2	2	3	3	1
CO3	3	3	3	3	2	2	2	3	3	1
CO4	3	3	3	3	2	3	2	3	3	3
CO5	3	3	3	3	3	2	3	3	3	3
Average	3	2.6	3	3	2.2	2.2	2	3	3	1.8

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5201	Entomology & Immunology Lab	Core	4	2

Entomology lab course highlights the collection, identification and preservation of insects. It also includes the study of various systems and physiology of insects. Immunology laboratory part includes antigen administration, bleeding techniques and agglutination assays. It also includes lymphoid organs in vertebrates, complement mediated lysis, hypersensitivity reactions and cellular immune response in fish.

### Course Outcomes

At the end of the course, students will be able to:

**CO1:** Evaluate the collection, preservation, identification of insect fauna and preparation of dichotomous key.

**CO2:** Explain digestive and reproductive system of *Mylabris* and *Periplanata*.

**CO3:** Assess the insect fauna of ecosystems and insect damage.

**CO4:** Examine the lymphoid organs, bleeding techniques, raising polyclonal antisera and quantify the antigen using agglutination and precipitation reactions.

**CO5:** Prepare lymphocytes from peripheral blood sample and analyze the graft rejection in fish.

### I. Lab in Entomology

#### Laboratory Exercises:

1. Collection, preservation and identification of insects.
2. Preparation of dichotomous key.
3. *Mylabris* – digestive and reproductive system.
4. *Periplanata* – mouth parts and reproductive system.
5. Survey of insect fauna in college campus/Alagar hills/Kodaikanal hills.
6. Collection and identification of soil micro-arthropods (Berleese funnel method).
7. Survey of insect fauna of an Agro-ecosystem.
8. Culture and damage assessment of a polyphagous pest (*Spodoptera litura*).
9. Evaluation of efficacy of a chitin inhibitor.
10. Study of the antennal grooming in cockroach.

11. Preparation of permanent slides (Cockroach mouth parts).
12. Rearing of silkworm.
13. Maintenance of butterfly garden.

## **II. Lab in Immunology**

### **Laboratory Exercises:**

1. Identification of various immune tissues and organs in fish
2. Lymphoid organs in chick.
3. Preparation of soluble and particulate antigens using Bovine serum albumin
4. Separation of RBC as intact cellular antigen for immunization
5. Antigenic challenge through different routes.
6. Repetitive bleeding techniques and separation of antiserum
7. Determination of haemagglutination titer of IgM antibodies.
8. Detection of IgG by precipitation ring test. (SRID)
9. Detection of IgG by Ouchterlony double immuno-diffusion test
10. Detection of reactivity of IgG with fractionated antigens by immune - electrophoresis
11. Separation of lymphocytes from peripheral blood and identification of T and B cells.
12. Hypersensitivity – foot pad thickening.
13. Scale rejection in Fish.
14. Laboratory visit

### **References**

1. Alka Prakash (2001). Laboratory manual of entomology, New age international (p) Ltd, First edn New Delhi.
2. Trigunayat M.M (2016). A manual of practical entomology (field and laboratory guide), 3<sup>rd</sup> edn Scientific publishers (India), Jodhpur.
3. Garvey JS, Cremer NE and Sussdorf DH (1977). Methods in Immunology, Third edn, Benjamin Cummings Publishing Co, Massachusetts, USA.
4. Richards OW and Davies RG (1977). Imm's General Textbook of Entomology, Vol-1 & 2, Tenth edn, BI Publications Pvt. Ltd, New Delhi.

5. Harisha S (2007). Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, New Delhi.
6. Hudson L and Hay FC (1989). Practical Immunology, Third edn, Blackwell Science Publishing, London.
7. Myers RL (1989). Immunology - A laboratory Manual, Wm C Brown Publishers, Dubuque, Iowa, USA.

**Websites/ e-Learning Resources:**

1. <https://iv11-au.vlabs.ac.in/exp/isolation-of-lymphocytes/>
2. [https://www.avit.ac.in/lab/immunology\\_bioprocess\\_engineering\\_lab/download/17BTCC89/lab\\_manual.pdf](https://www.avit.ac.in/lab/immunology_bioprocess_engineering_lab/download/17BTCC89/lab_manual.pdf)
3. [https://webstor.srmist.edu.in/web\\_assets/downloads/2021/18BTC106J-lab\\_manual.pdf](https://webstor.srmist.edu.in/web_assets/downloads/2021/18BTC106J-lab_manual.pdf)
4. <https://sc.uobaghdad.edu.iq/wpcontent/uploads/sites/64/mainfiles/lectures/biotech/%D9%85%D9%86%D8%A7%D8%B9%D9%87%20%D8%B9%D9%85%D9%84%D9%8A.pdf>
5. [https://www.kau.edu.sa/Files/0011104/Subjects/Final%20Immunology%20practical%20part%20All%20labs%202%20\(1\)%20\(1\).pdf](https://www.kau.edu.sa/Files/0011104/Subjects/Final%20Immunology%20practical%20part%20All%20labs%202%20(1)%20(1).pdf)

**CO – PSO Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	3	3	3	3	2	1
CO2	3	3	3	2	3	3	2	2	2	1
CO3	2	2	3	3	3	3	2	2	3	1
CO4	3	2	2	3	3	3	3	3	2	1
CO5	3	2	3	3	3	3	3	3	2	1
Average	3	2.4	2.6	2.6	3	3	2.6	2.6	2.2	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5403	Bioinformatics (TcL)	Core	6	4

This course deals with the information of biological databases, file formats, data analysis tools and higher-level applications. It emphasizes the concept of sequence analysis, sequence alignment tools, phylogenetic analysis methods, protein structure prediction, PCR primer designing and epitope prediction for vaccine development.

**Course Outcomes:**

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

**CO1:** Explain the basics of bioinformatics, internet, World Wide Web, search engines and searching methods.

**CO2:** Analyse various types of biological data sets and formats.

**CO3:** Summarize different types of biological databases.

**CO4:** Examine various bioinformatics tools for sequence alignment and homology study.

**CO5:** Construct phylogenetic trees and explain the drug discovery approach.

**UNIT 1: (12 Hours)**

**Introduction to Bioinformatics and Internet:** Components of Bioinformatics- Overview of Internet - World Wide Web – HTML, URL, Domain name, IP Address - Important bioinformatics resources available in WWW - Search engines - Searching the Web-Boolean operators

**UNIT II: (12 Hours)**

**Biological Data:** Definition, sources, classification, Biological bigdata - Molecular Biology connection -High throughput techniques and large data generation (Genome Projects) – Sequence data- formats – Structure data-types, formats.

**UNIT III: (12 Hours)**

**Biological Databases:** Classification - Nucleic acid sequence databases - GenBank, EMBL and DDBJ. Protein sequence databases – Primary, Secondary and composite –

Genome Databases - TIGR and SANGER. Structure databases-PDB, CATH and SCOP – Specialized database - PUBCHEM, OMIM.

**UNIT IV: (12 Hours)**

**Sequence Retrieval and Analysis:** Sequence similarity, identity and homology. Sequence Retrieval System, Entrez - Scoring matrices – PAM-BLOSUM – Sequence alignments (local and global) – Heuristic Methods of sequence alignment - FASTA, BLAST – Multiple Sequence Alignment - ClustalW –ClustalR – TOFFEE.

**UNIT V: (12 Hours)**

**Applications of Bioinformatics:** Phylogenetic Analysis – Tree types-construction methods – Distance based – UPGMA, NJ – Character based – MP, ML - Homology Modelling –SWISS-MODEL server - Drug discovery - identifying the lead compound and the target - Molecular docking –types - softwares-Pyrex – R programming.

**Learning Resources:**

**Text Books**

1. Attwood TK and Parry-Smith. (2001). Introduction to Bioinformatics. I Edition, Pearson Education, New Delhi.
2. Baxevanis AD and Francis Ouellette BF (2001). Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. 2<sup>nd</sup> Edn. John Wiley & Sons, USA.
3. Ignacimuthu S (2005). Basic Bioinformatics. II Edition, Narosa Publishing House, New Delhi.

**References**

1. Claverie JM and Notredame C (2006). Bioinformatics for Dummies. II Edition, John Wiley & Sons, Inc., USA.
2. Claverie JM and Notredame C (2003). Bioinformatics – A Beginner’s Guide. Wiley Publishing Inc., USA.
3. Clote P and Backofen R (2000). Computational Molecular Biology: An Introduction. John Wiley & Sons Ltd., England.

**Websites/ e-Learning Resources:**

1. <http://www.dartmouth.edu/pages/softdev/fetch.html>
2. <http://www.metacrawler.com>
3. <ftp://ncbi.nlm.nih.gov/genbank/gbrel.txt>
4. [http://www.ebi.ac.uk/ebi\\_docs/swissprot\\_db/documentation.html](http://www.ebi.ac.uk/ebi_docs/swissprot_db/documentation.html)
5. <http://blocks.fhcr.org>
6. <http://www.expasy.ch/swissmod/SWISS-MODEL.html>
7. <http://www.rcsb.org/>

**Lab in Bioinformatics****Laboratory Exercises:**

1. PubMed-literature search with Boolean operators
2. Biological database search and retrieval of sequences
3. BLAST and FASTA homology search
4. Protein secondary structure search
5. Protein secondary structure evaluation – Prosite
6. Multiple sequence analysis and phylogenetic tree construction
7. Predicting Open Reading Frames
8. Predicting coding and non-coding regions
9. Predicting the Restriction sites in nucleotide sequences
10. PCR Primer designing
11. B cell & T cell epitope prediction
12. Searching lead molecules in PUBCHEM database.
13. Sequence data upload in GenBank.

**References**

1. Lesk, AM (2002). Introduction to Bioinformatics. I Edition, Oxford University Press, USA.
2. Xiong, J (2006). Essential Bioinformatics. Cambridge University Press, New York.

**Websites/ e-Learning Resources:**

1. <http://http://www.expasy.ch/spdbv/mainpage.html>

2. <http://www.ncbi.nlm.nih.gov/Toolbox>
3. <http://ncbi.nlm.nih.gov/BLAST/>
4. <ftp://ftp.ebi.ac.uk/pub/software/>
5. <ftp://ftp.sanger.ac.uk/pub/dotter/>
6. <http://www.Bork.EMBL-Heidelberg.DE/Blast2e/>
7. <http://www-igbmc.u-strasbg.fr/BioInfo/>
8. <http://taxonomy.zoology.gla.ac.uk/rod/treeview.html>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	2	2	3	1
CO2	3	3	3	3	3	3	2	2	3	1
CO3	3	3	3	3	3	3	2	2	3	1
CO4	3	3	3	3	3	3	2	2	3	1
CO5	3	3	3	3	3	3	2	2	3	1
Average	3	3	3	3	3	3	2	2	3	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/wk	Credits
24PGZ5301	Applied Zoology	DSE	3	3

This course is a subfield of zoology that focuses on the animal world that is associated with the economy, health and welfare of humans. It involves mass producing animals for human use through various culture methods. It will also provide information about economic aspects of culturing animals and promote community and youth development.

### Course Outcomes

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

**CO1:** Express skills to perform bee keeping and managing bee colonies to harvesting honey other as an Entrepreneurial venture.

**CO2:** Apply the various techniques in sericulture.

**CO3:** Explain the various practices in dairy farming and apply the techniques and practices.

**CO4:** Employ rigorous practical experience in a poultry farm and improve self-confidence for entrepreneurship.

**CO5:** Evaluate the various practices in vermiculture and their economic importance.

### UNIT I: (9 Hours)

**Apiculture:** History – classification - life cycle (*Apis indica*) - behaviour. Social organization - tools - Types of bee hives. Diseases – Bacterial (European foul-brood), Viral (Thai sac brood virus), Pest (Wax moths). Bee products (Honey, Royal jelly, Propolis, Pollen and Bee venom) – Harvesting – Processing - Packaging and Marketing - Central Bee Research & Training Institute in India - National Bee Board - KVIC - Devbhumi Natural Products Producers - IDBI Bank Bee Keeping Madhu Makshika Palan (Apiculture).

### UNIT II: (9Hours)

**Sericulture:** History, development – Moriculture (*Morus alba*) – morphology & varieties. *Bombyx mori*- morphology, life cycle, voltinism. Diseases & Pests – Protozoan

(Pebrine), Bacterial (*Flacherie*), Viral (*Grasserie*), Pest (Uzi fly). Rearing - harvesting and marketing - By-products – Central Silk Board - National Silkworm Seed Organization (NSSO) - Silk Samagra Scheme for Development of Sericulture – Department of Sericulture, Tamil Nadu.

**UNIT III: (9 Hours)**

**Dairy Farming:** Introduction - Classification -Indigenous and exotic breeds - Construction of Model House - Winter Management - Summer Management - Feedstuffs available for livestock- Roughage - Feeding management - Milk products (Cream, Butter, Cheese, Yogurt, Casein). Disease - Protozoan (*Theileriosis*) Bacterial (*Anthrax*), Viral Diseases (Foot and mouth) - Union Krishi Kamdhenu Gold Loan Scheme – Bank of Baroda (livestock loans).

**UNIT IV: (9 Hours)**

**Poultry farming:** Poultry industry in India - house – Equipment - Management - growers and layers (summer & winter) - Feed formulation - Diseases – Bacterial (Fowl cholera), Fungal (*Aspergillosis*), Viral (Ranikhet) – recycling of poultry wastes – Vaccination - Preparation of project report for banking and insurance – National Bank for Agriculture and Rural Development (NABARD) - Central Poultry Development Organization - Axis Bank (Poultry power) - Kisan Credit Card Scheme.

**UNIT V: (9 Hours)**

**Vermiculture:** Introduction - Earthworms - external features – Vermitechnology - culture methods - breeding techniques - monoculture and polyculture. Vermicomposting – Vermicast - earthworms for municipal/ biomedical solid waste management. By-products of vermiculture - Ministry of Skill Development and Entrepreneurship - National Agriculture Development Programme - Central Bank of India (Cent Vermicompost Scheme).

## **Learning Resources:**

### **Text Books**

1. Caron, D.W (2013). Honey Bee Biology and Beekeeping. Wicwas Press. Cheshire, CT.
2. Ganga G. and Sulochana Chetty J (2019). An introduction to sericulture, 2nd edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Johnson. M and Kesary, M (2019). Sericulture, Saras publication, Tamil Nadu.
4. Jaiswal V and Jaiswal KK (2014). Economic Zoology, PHI Learning Private Limited, New Delhi.
5. Gnanamani MR (2003). Modern Aspects of Commercial Poultry Keeping, Ninth edn, Giri Publications, Madurai.
6. Bhatnagar & Patla (2007). Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi

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1. Mishra R.C (2013). Prospective in Indian Apiculture. Bio-Green Books.
2. Singh, D., Singh, D. Pratap (2006). A Handbook of Beekeeping. AGROBIOS.
3. Singh, A and Ravinder Kumar (2013). Sericulture Handbook Vol 1, Biotech.
4. Rao M.M (2019). An Introduction to Sericulture, 2nd edition, BS Publications.
5. Tata, S.N (1990). Handbook of animal husbandry, ICAR.
6. Christy M.V (2008). Vermitechnology, MJP Publishers, Chennai.
7. Aravind Kumar (2005). Verms & Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
8. Ismail, S.A (1997). Vermitechnology, The biology of earthworms, Orient Longman, India.

### **Websites/ e-Learning Resources**

1. <https://www.nal.usda.gov/animal-health-and-welfare/beekeeping#>
2. [https://agritech.tnau.ac.in/farm\\_enterprises/fe\\_apiculture\\_home.html](https://agritech.tnau.ac.in/farm_enterprises/fe_apiculture_home.html)
3. <https://agritech.tnau.ac.in/sericulture/>
4. <https://csb.gov.in/>
5. <https://www.britannica.com/topic/dairying>

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7. <https://www.britannica.com/topic/poultry-farming>
8. [https://agritech.tnau.ac.in/farm\\_enterprises/Farm%20enterprises\\_%20poultry%20unit.html](https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20poultry%20unit.html)
9. <https://www.sciencedirect.com/topics/earth-and-planetary-sciences/vermiculture>
10. [https://iweco.org/sites/default/files/2019-03/GEF-IWCAM\\_Manual\\_Vermiculture\\_2012.pdf](https://iweco.org/sites/default/files/2019-03/GEF-IWCAM_Manual_Vermiculture_2012.pdf)
11. [https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/ELearning/Moocs/Solid\\_Waste/W4/Manual\\_On\\_Farm\\_Vermicomposting\\_Vermiculture.pdf](https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/ELearning/Moocs/Solid_Waste/W4/Manual_On_Farm_Vermicomposting_Vermiculture.pdf)

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	3	3
CO2	3	3	3	3	3	3	3	3	3	3
CO3	3	3	3	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	2	3	3	3	3	3	3
Average	3	3	3	2.8	3	3	3	3	3	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - 0-**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5303	Animal Behaviour	DSE	3	3

The objective of this course is to expose students to the broad field of animal behaviour. This course includes theories, communication, behavioural changes in environment, understanding complex behaviour and chronobiology.

### Course Outcomes

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

**CO1:** Outline the inheritance of behaviour.

**CO2:** Describe the social adaptations in animals.

**CO3:** Analyze the innate, learned and cognitive behaviour of animals.

**CO4:** Assess the complexity in behavioural traits, evaluate hormones their role in aggression and reproduction.

**CO5:** Discuss the rhythmicity of behavioural expressions.

### UNIT I: (9 Hours)

**Introduction to Animal Behaviour:** Single and Polygenic inheritance of behaviour - heritability of behaviour - Natural selection and behaviour - Frequency distribution of phenotypes - Darwinian fitness - Evolution of adaptive strategies.

### UNIT II: (9 Hours)

**Social Organization and Adaptation in Animals:** Sexual selection – Altruism- Sexual strategy and social organization - Animal perception - Neural control of behaviour - Sensory processes and perception - Visual adaptations to unfavourable environments.

### UNIT III: (9 Hours)

**Environment and Animal Behaviour:** Coordination and Orientation - Homeostasis and Behaviour - Physiology and Behaviour in changing environments - Animal Learning - Conditioning and Learning - Biological aspects of learning - Cognitive aspects of learning.

**UNIT IV:****(9 Hours)**

**Complex Behaviour in Animals:** Instinct and learning - Displacement activities - Ritualization and Communication – Decision making behaviour - Complex behaviour of honey bees - Evolutionary optimality - Mechanism of Decision making. Mentality of Animals - Languages and mental representation - non-verbal communication in human - mental images - Intelligence, tool use and culture - Animal awareness and Emotion.

**UNIT V****(9 Hours)**

**Chronobiology:** Organization of circadian system in multicellular animals - Concept of central and peripheral clock system - Circadian pacemaker system in invertebrates (*Drosophila*) - Photoreception and photo- transduction - Molecular basis of seasonality - relevance of biological clocks for human welfare - Clock function (dysfunction) - human health and diseases – chronopharmacology – chronomedicine - chronotherapy.

**Learning Resources:****Text Books**

1. Chandrashekar, M.K (2006). Time in the Living World, University Press India Ltd, Hyderabad.
2. Hoshang S.Gundevia and Hare Govind Singh (1996). Animal Behaviour, S.Chand & Co, New Delhi.
3. Mathur, R (2021). Animal Behavior - A Text Book for University Students, Rastogi Publications, Meerut.
4. Shukla, J. P (2023). Fundamentals of Animal Behaviour, Atlantic Publishers and Distributors (P) Ltd, New Delhi.
5. Vinod Kumar (2002). Biological Rhythms. Narosa Publishing House, Delhi.

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1. Bunning, E (1967). The physiological clock, Endogenous Diurnal Rhythms and Biological Chronometry, Academic Press Inc., Publishers, New York.

2. Girer, J.W (1984). *Biology of Animal Behaviour*. Mosby College Publisher, Missouri.
3. Michael D. Breed and Janice Moore (2012). *Animal Behaviour*, Academic Press, USA.
4. Manning A and M.S. Dawkins (2012). *An Introduction to Animal Behaviour*, 6<sup>th</sup> Edition, Cambridge University Press, UK.
5. Davis E. Davis (1970). *Integral Animal Behaviour*, Mac Millan Company, London.
6. Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (2004). *Chronobiology Biological time Keeping*, Sinauer Associates Inc, Publishers, Sunderland, MA.
7. Manning A and Dawkins M.S (2012). *An Introduction to Animal Behaviour*, 6<sup>th</sup> edition, Cambridge University Press, UK.

#### **Websites/ e-Learning 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. <https://www.bbau.ac.in/dept/dz/TM/ZL%20202%20Animal%20Behaviour.pdf>

#### **CO – PSO Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	2	1	2	3	2	3	2	2	3	3
CO 2	3	3	3	2	3	3	3	2	3	3
CO 3	2	3	2	3	2	2	3	3	2	2
CO 4	3	3	3	2	3	2	3	2	1	2
CO 5	3	3	3	3	3	3	2	1	3	3
Average	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2	1.8	2.6

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation ‘-’**

Course Code	Name of the Course	Category	Hours/wk	Credits
24PGZ5233	INTERNSHIP	IS	-	2

Internship includes exposure of students to real work experience, deliver time, gain knowledge through hands on training and job execution. The industrial training, will develop skills, communication, management and team work. The practical training program helps to relate theoretical knowledge with its application.

### Course outcomes

At the end of the course, students will be able to:

**CO1:** Evaluate their interest and opportunity in a particular career.

**CO2:** Examine and gain the knowledge by hands on training and job execution.

**CO3:** Analyze the strength, teamwork spirit and self-confidence.

**CO4:** Express the sense of responsibility and good work culture.

**CO5:** Interpret the knowledge and experience gained in writing report and solving problems.

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	2	3	3	3	3	3	3	3	3	3
CO2	3	3	3	3	3	3	2	3	2	3
CO3	2	3	3	3	3	2	3	2	2	3
CO4	2	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	2	3	3	3
Average	2.4	3	3	3	3	2.8	2.6	2.8	2.6	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5402	Biotechnology	Core	5	4

This course deals with recombinant DNA technology, emphasizes the importance of animal and plant tissue culture, production and applications of transgenic animals and plants. Disease diagnosis and therapeutics using biotechnology tools and industrial applications of genetically modified organisms will also be dealt. The course also deals with remedies for environmental pollution using recombinant microbial strains, bioethics of biotechnological products.

### Course Outcomes

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

**CO1:** Discuss the importance of enzymes, gene transfer methods and techniques in biotechnology.

**CO2:** Explain the procedures in animal cell culture and applications.

**CO3:** Outline the overall process in plant tissue culture and applications.

**CO4:** Analyze the principles in formulating pharmaceutical industrial products.

**CO5:** Evaluate the role of microbes in environmental biotechnology.

### UNIT I: (15 Hours)

**Introduction and Recombinant DNA Technology:** History and Scope of Biotechnology – DNA modifying enzymes- linkers & adaptors - vectors (*E. coli*, phage yeast, plant & animal viral vectors) - gene transfer methods - gene cloning strategies. Techniques in genetic engineering - blotting techniques - PCR and its types - DNA sequencing - Human Genome Project.

### UNIT II: (15 Hours)

**Animal Biotechnology:** Animal cell culture media - Biology and characterization of cultured cells - Primary & secondary cell culture - Tissue and stem cell engineering - Transgenic animals - fish, cattle and gene knockout mice - applications. Cloning mechanism - Dolly - Ploidy induction method in fish. Hybridoma technology - Monoclonal antibody production.

**UNIT III: (15 Hours)**

**Plant Biotechnology:** Basic concepts in plant tissue culture - micropropagation - protoplast culture and somatic hybridization - haploid plant production - gene transfer in plants - vector mediated (Ti plasmid) and virus mediated. Transgenic plants - resistance to biotic stress (insect and microbes) and abiotic stress (phosphinothricin and glyphosate) - improvement of crop yield, quality and nutrition.

**UNIT IV: (15 Hours)**

**Pharmaceutical and Industrial Biotechnology:** Gene therapy - *ex vivo* & *in vivo*. DNA assay for disease diagnosis and DNA profiling in forensics. Pharmaceutical products - insulin, tissue plasminogen activator, recombinant vaccines. Bioprocess and enzyme technology - production and immobilization of enzymes - biosensors. Biomass production - citric acid, alcohol and bio-fuel (hydrogen and methane).

**UNIT V: (15 Hours)**

**Environmental Biotechnology and Society:** Environmental pollution - biotechnological methods for monitoring and management. Biodegradation & Bioremediation – Xenobiotics - Genetically engineered microorganisms in bioremediation. Biotechnology - risks, ethics and patenting biotechnology inventions.

**Learning Resources:**

**Text Book**

1. Satyanarayana U (2012). Biotechnology, First edn, Books and Allied (P) Ltd, Kolkata.

**References**

1. Brown, TA (2017). Gene cloning and DNA analysis: an introduction, Seventh edn, John Wiley & Sons, USA.
2. Brown TA (2017). Genomes 4, Fourth edn, Garland Science (Taylor & Francis Group), New York.
3. Dubey RC (2006). A Textbook of Biotechnology, First multicolour illustrative edn, S. Chand & Company Ltd, New Delhi.

- Primrose SB and Twyman R (2006). Principles of Gene Manipulations and Genomics, Seventh edn, Blackwell Publishing, Massachusetts, USA.
- Glick RB and Pasterneck JJ (2002). Molecular Biotechnology - Principles and Application of Recombinant DNA, Panima publishing corporation, New Delhi.

### Websites/ e-Learning Resources

- <https://www.davuniversity.org/department/department-of-biotechnology-study-material>
- [https://www.easybiologyclass.com/topic-biotechnology/#google\\_vignette](https://www.easybiologyclass.com/topic-biotechnology/#google_vignette)
- <https://dnalc.cshl.edu/resources/dnalc-live/watch/20200413-forensic-dna-analysis-17124>
- <https://www.nursinghero.com/study-guides/boundless-biology/biotechnology>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	3	2	1
CO2	3	3	3	2	3	3	3	3	2	1
CO3	3	3	3	2	3	3	3	3	2	1
CO4	3	3	3	3	3	3	3	3	2	1
CO5	3	3	3	3	3	3	3	3	2	1
Average	3	3	3	2.4	3	3	3	3	2	1

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/wk	Credits
24PGZ5404	Developmental Biology	Core	5	4

The course aims at imparting knowledge on various aspects and concepts in ontogenetic development of animals that include gametogenesis, fertilization, cleavage, gastrulation and organogenesis. It exclusively discusses the process of human development.

### Course Outcomes

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

**CO1:** Describe the concepts of spermatogenesis and oogenesis.

**CO2.** Outline the processes of fertilization and post fertilization.

**CO3.** Explain cleavage and gastrulation in selected animals.

**CO4.** Analyse organogenesis and the role of genes.

**CO5.** Discuss the human development, regeneration and *in vitro* fertilization.

### UNIT I: (15 Hours)

**Pattern of animal development:** Chief events in animal development - history of thoughts and conceptual developments - Gametogenesis - origin of germ cells, spermatogenesis - sperm morphology - Oogenesis - Oogenesis in insects and amphibians. Composition and synthesis of yolk in invertebrates (insects and crustaceans) and vertebrates - Genetic control of vitellogenin synthesis.

### UNIT II: (15 Hours)

**Fertilization:** Sperm aggregation - sperm activation - chemotaxis, sperm maturation and capacitation in mammals - acrosome reaction. Sperm – egg interaction. - sperm entry - egg activation - intracellular calcium release - cortical reaction - physiological polyspermy - fusion of male and female pronuclei - post fertilization metabolic activation – parthenogenesis.

**UNIT III: (15 Hours)**

**Cleavage and gastrulation:** Pattern of embryonic cleavage - mechanisms of cleavage, mid blastula transition - determinate and regulatory embryos - factors affecting gastrulation - mechanisms and types of gastrulation (Sea urchin, *Amphioxus*, Amphibians, Aves & Mammals) - Fate maps - (Amphibian and Chick) - Epigenesis and preformation – formation of primary germ layers – embryonic induction – Spemann’s primary organizer – embryonic differentiation and their molecular basis.

**UNIT IV: (15 Hours)**

**Embryonic Development:** Embryonic development of kidney, eye and heart in fish and birds - extra embryonic membranes in mammals - development of endodermal, mesodermal and ectodermal derivatives - formation, types migration and patterning of neural crest cells- genes and development –axial formation in *Drosophila* - effect of maternal genes - Bicoid and Nanos proteins - Dorso –ventral polarity and segmentation. Role of gap genes, pair rule genes and homeotic genes in polarity.

**UNIT V (15 Hours)**

**Post embryonic development metamorphosis:** Metamorphosis in amphibian - morphological, physiological, biochemical and hormonal changes - moulting and growth in crustaceans - neoteny and pedogenesis. Regeneration in earthworm and Planaria - biochemical changes - factors affecting regeneration - Nucleo-cytoplasmic interaction and control- experiments in amphibians and *Acetabularia*. Mammalian reproductive cycle and hormonal regulation-hormonal changes during pregnancy-induced gametogenesis in human- *In-vitro* fertilization techniques – ICSI, GIFT & ZIFT - cryopreservation of gametes and embryos - ethical issues involved – birth defects-abnormal pregnancy and teratology. Ageing - biology - causes -mechanism of apoptosis.

**Learning Resources:**

**Text Book**

1. Balinsky B I (2012). An introduction to Embryology, Fifth edn, Cengage Learning India.

## References

1. Browder W, Drickson and Jeffery WR (1991). Developmental Biology, Third edn, Saunders College Publishing, USA.
2. Gilbert SF (1997). Developmental Biology, Fifth edn, Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, USA.
3. Wolpert (1998). Principles of Development, Oxford University Press, London

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1. [https://bio.libretexts.org/Bookshelves/Introductory\\_and\\_General\\_Biology/General\\_Biology\\_\(Boundless\)/43%3A\\_Animal\\_Reproduction\\_and\\_Development/43.03](https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/General_Biology_(Boundless)/43%3A_Animal_Reproduction_and_Development/43.03)
2. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5835147/>
3. [https://www.cell.com/trends/cell-biology/fulltext/S0962-8924\(21\)00148-3](https://www.cell.com/trends/cell-biology/fulltext/S0962-8924(21)00148-3)
4. <https://www.ncbi.nlm.nih.gov/books/NBK10040/>
5. <https://www.ncbi.nlm.nih.gov/books/NBK10040/>
6. <https://courses.lumenlearning.com/wm-lifespandevelopment/chapter/defining-human-development/>

## CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	3	2	1	3	1	1
CO2	3	3	1	1	3	2	1	3	2	1
CO3	3	3	1	1	1	2	1	3	2	1
CO4	3	3	3	2	3	2	1	3	2	1
CO5	3	3	2	1	1	2	1	3	3	1
Average	3	3	1.6	1.2	2.2	2	1	3	2	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5406	Ecology	Core	5	4

This course deals with the principles and scope of environmental biology. Special emphasis is given to environmental chemistry, geosciences, energy resources & conservation.

### Course Outcomes

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

**CO1:** Discuss physical, biotic environment and resource partitioning.

**CO2:** Evaluate the nature of population, community and species interactions.

**CO3:** Analyze the species interaction and ecological succession.

**CO4:** Compare structure and function of ecosystems and assess their primary productivity.

**CO5:** Outline environmental pollution and conservation strategy.

### UNIT I: (15 Hours)

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

### UNIT II: (15 Hours)

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

### UNIT III: (15 Hours)

**Species Interactions:** Types of interactions - interspecific competition - herbivory, carnivory – pollination - symbiosis. Community ecology - Nature of communities - community structure and attributes - levels of species diversity and its measurement -

edges and ecotones. Ecological succession – types – mechanisms - changes involved in succession - concept of climax

**UNIT IV: (15 Hours)**

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

**UNIT V: (15 Hours)**

**Applied ecology:** Environmental pollution – health hazards - global environmental change – climate change - biodiversity status - monitoring and documentation - major drivers of biodiversity change - biodiversity management approaches - waste management. Conservation biology - principles of conservation - major approaches to management - Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

**Learning Resources:**

**Text Book**

1. Verma PS and Agarwal VK (2000). Environmental Biology- Principles of Ecology, S. Chand & Co Ltd, New Delhi.
2. Odum EP and Barret GW (2004). Fundamentals of Ecology, Fifth edn, Brooks/Cole, USA.

**References**

1. Cox GW (1997). Conservation Ecology - Concepts and application, Appleton Century Crofts, USA.
2. Curtis LF and Barrett EC (1992). Introduction to Environmental Remote Sensing, Springer, Netherlands.
3. Dwivedi OP (2016). India's Environmental Polices, Programmes and Stewardship, Macmillan Press Ltd, Chennai.

4. Keller EA (2012). Environmental Geology, Eighth edn, Pearson Prentice Hall, USA.
5. Sodhi GS (2000). Fundamental Concepts of Environmental Chemistry, Third edn, Alpha Science International Ltd, UK.
6. Stiling P (2009). Ecology: Theories and Applications, Fourth edn, PHI Learning Pvt. Ltd, New Delhi.

### Websites/ e-Learning Resources

1. <https://www.psychologytoday.com/us/basics/environment>
2. <https://www.britannica.com/science/population-ecology/Population-density-and-growth>
3. <https://www.nature.com/scitable/knowledge/library/species-interactions-and-competition-102131429/>
4. <https://en.wikipedia.org/wiki/Ecosystem>
5. <https://kinnu.xyz/kinnuverse/science/ecology/applied-ecology/>

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	3	3	2	2	2	3
CO2	3	3	3	3	3	3	2	2	2	3
CO3	3	3	3	3	2	3	2	2	2	3
CO4	3	3	2	2	3	3	2	2	2	3
CO5	3	3	2	2	3	3	2	3	2	3
Average	3	3	2.4	2.4	2.8	3	2	2.2	2	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24 PGZ5302	Biotechnology, Developmental Biology & Ecology Lab	Core	6	3

This laboratory course in Biotechnology includes the basic animal and plant biotechnology experiments. It deals with extraction & manipulation of DNA, PCR analysis, microbial degradation of pollutants, animal & plant tissue culture. Laboratory course in Development Biology will impart knowledge and hands on training in the study of various aspects of development in some animals. Laboratory course in Environmental Biology involves exercises to understand the principles and concepts of ecosystem, plankton diversity, analysis of pollutants in air, water samples and to apply environmental data using GIS and remote sensing.

### Course Outcomes

At the end of this course, students will be able to:

- CO1:** Demonstrate and understand the applications of biotechnology techniques.
- CO 2:** Identify the developmental stages of gametes in various species.
- CO3:** Compare various stages of chick development and regeneration mechanism in earthworm and tadpole.
- CO4:** Evaluate primary productivity and physico-chemical parameters of water samples.
- CO5:** Analyze the levels of pollutants in air, water samples and to apply environmental data using GIS and remote sensing.

### I. Lab in Biotechnology

#### Laboratory Exercises:

1. Isolation of plasmids from *E.coli*
2. Agarose gel electrophoresis of DNA
3. DNA amplification by PCR method - Demonstration.
4. Restriction enzyme digestion of DNA.
5. DNA Ligation
6. Polyacrylamide gel electrophoresis

7. Western blotting – Demonstration.
8. Preparation of primary suspension culture of liver tissue
9. Chick embryo fibroblast- monolayer and suspension culture (Trypsinization)
10. Induction of callus from leaf discs
11. Formation of shoot and root of *Oryza sativum*.
12. Pesticide degradation using *Pseudomonas*.
13. Degradation of cellulose using *Bacillus*.
14. Biogas production.
15. Visit to industry/lab/research institute.

## **II. Lab in Developmental Biology**

### **Laboratory Exercises:**

1. Observation of gametes from gonadal tissue sections
2. Microscopic observation of sperm and ovum.
3. Cross section through ovary of shrimp, fish, frog and mammals
4. Observation on various embryonic developmental stages in frog.
5. Observation of slide showing C.S. of heart, kidney and eye.
6. Study of slides showing direct and indirect larval forms (Trochophore and Veliger).
7. Dissection and mounting of blastoderm at various developmental stages of chick – 24, 48, 72 and 96 hours of development.
8. Demonstration of regenerative process in earthworm and tadpole.
9. Role of thyroxin on the metamorphosis of tadpole.

## **III. Lab in Ecology**

### **Laboratory Exercises:**

1. Identification of fauna and flora of terrestrial and freshwater ecosystem in the American College campus
2. Qualitative estimation of phytoplankton by Luky's drop method and zooplankton by Sedgwick-Rafter cell method.
3. Estimation of primary productivity: light and dark bottle method – effect of depth and light

4. Toxicity test – Estimation of LC<sub>50</sub> values
5. Analysis of BOD in water samples
6. Analysis of COD in water samples
7. Determination of portability of water by using coagulant demand, chlorine demand and residual chloride methods.
8. Estimation of physical and chemical parameters of water (Dissolved oxygen, Calcium, Magnesium, Total Alkalinity and Total Hardness).
9. Analysis of heavy metals and pesticides in water by using spectrophotometry.
10. Analysis of particulate matter.
11. Organize and analyse environmental data from remote sensing and GIS.
12. Visiting various ecosystems and prepare a report.

### **Learning Resources:**

#### **References**

1. Becker JM, Caldwell GA and Zachgo EA (1996). Biotechnology – A Laboratory Course, Second edn, Academic Press, San Diego, USA.
2. Harisha S (2007). Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, New Delhi, India.
3. Laura RK, Evans JH and Keller TCS (1999). Experimental Developmental Laboratory: A Laboratory Manual, Academic Press, UK.
4. Rajamanickam C (2001). Experimental Protocols in Basic Molecular Biology. Osho Scientific Publishers, Madurai.
5. Sambrook J and Russell DW (2001). Molecular cloning: A Laboratory Manual, Third edn, Cold Spring Harbor Press, New York.
6. Tyler MS (2010). Developmental Biology, A Guide for Experimental Study, Third edn, Sinauer Associates. Sunderland, Massachusetts, USA.
7. Agarwal SK (2002). Industrial environment: assessment and strategy, APH Publishers, New Delhi.
8. Allen JRL (1977). Physical Process of Sedimentation, Allen & Unwin, London.
9. Eaton, AD and Franson MAH (2005). Standard methods for the examination of water and waste water. American Public Health Association, American Water Works Association, the Water Environment Federation, Washington DC.

10. Lynn LM (2010). Environmental Biology and Ecology Laboratory manual, Fifth edn, KendallHunt Publishing, USA
11. Odum EP and Barrett GW (2005). Fundamentals of Ecology, Fifth edn, East West Press Pvt. Ltd, New Delhi.
12. Subramanyam NS and Sambamurty AVSS (2000). Ecology, Narosa Publishing House, Chennai.

### Websites/ e-Learning Resources

1. [https://mbvi-au.vlabs.ac.in/molecular-biology-1/Agarose\\_Gel\\_Electrophoresis/](https://mbvi-au.vlabs.ac.in/molecular-biology-1/Agarose_Gel_Electrophoresis/)
2. [https://mbvi-au.vlabs.ac.in/molecular-biology-1/Plasmid\\_Isolation/](https://mbvi-au.vlabs.ac.in/molecular-biology-1/Plasmid_Isolation/)
3. <https://vlab.amrita.edu/index.php?sub=3&brch=272&sim=1414&cnt=1>
4. <https://vlab.amrita.edu/index.php?sub=3&brch=272&sim=1430&cnt=1>
5. <https://www.labster.com/simulations/embryology>
6. <https://egyankosh.ac.in/bitstream/123456789/57549/1/Exercise%207%20Chick%20Embryo.pdf>
7. <https://www.youtube.com/watch?v=4Y9jjwOWIHA>
8. [https://www.slideshare.net/hannahshane\\_soriano/frog-metamorphosis](https://www.slideshare.net/hannahshane_soriano/frog-metamorphosis)

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	2	2	2	1
CO2	3	3	3	3	3	3	2	2	2	1
CO3	3	3	3	3	2	3	3	2	2	1
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	3	2	2	3
Average	3	3	3	3	2.8	3	2.6	2	2	1.8

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5202	Wildlife Biology	DSE	3	2

This course deals with the essential elements, concepts and wildlife in India, wildlife Act, field techniques, conservation and management. It also focuses on essential elements, concepts and skills related to wildlife biology as census techniques, case studies, wild life conflicts and legislation. This also focuses on wildlife health and conservation by *in-situ* and *ex-situ* strategies.

### Course Outcomes

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

**CO 1:** Describe the wealth, threats and importance of wildlife in India.

**CO 2:** Record animal diversity using census techniques.

**CO 3:** Elucidate the human wildlife conflicts and legislation.

**CO 4:** Examine the diseases in wild animals.

**CO 5:** Discuss the conservation strategies of wild life.

### UNIT I: (9 Hours)

**Scope and Importance of Wildlife of India:** Wildlife in India - Wildlife wealth of India-India as a mega diversity nation. National and State mammals and birds of India. Threats to wildlife - Reasons for wildlife depletion. IUCN endemic species of fishes – amphibians – reptiles - birds and mammals in India.

### UNIT II: (9 Hours)

**Wildlife Census Techniques:** Planning census -Total counts - Sample counts - Basic concepts and applications. Direct count - block count - transect methods - point counts, visual encounter survey - waterhole survey - Indirect count- call count - track and signs - pellet count - pugmark - camera trap - Identifying animals - indirect signs - capture-recapture techniques. Field equipment -altimeter - pedometer - field compass – binoculars - radio collaring - GPS - GIS - eBird App.

**UNIT III: (9 Hours)**

**Human Wildlife Conflicts and Legislation:** Basic concepts - reasons for conflicts - damages caused by wild animals - control measures. Case studies - elephant - gaur - wild boar - monkey - tiger and leopard. Translocation of wild animals - principles - methods and applications. National Board for Wildlife - Wildlife (Protection) Act, 1972 – Amendments - Biodiversity Act, 2000 - Anti poaching operations - Village Forest Council (VFC).

**UNIT IV: (9 Hours)**

**Wildlife Health:** Introduction to disease and epizootiology - disease transmission, symptoms and control measures - viral (Rinderpest - Kyasanur forest disease), bacterial (Brucellosis - Clostridiosis), protozoan (Trypanosomiasis, Toxoplasmosis), fungal (Aspergillosis, Candidiasis) and parasitic diseases (Fasciolopsis - Schistosomiasis) in mammals - Emerging and re-emerging diseases - Zoonoses - health and nutritional status in free-ranging populations - disease control operations – investigation of disease outbreaks - biological sampling - laboratory analysis - Planning and management of wildlife health program.

**UNIT V: (9 Hours)**

**Wildlife Conservation:** Need for wildlife conservation - *in-situ* and *ex-situ* conservation - captive breeding of wild animals. Formation - management - administration of Wildlife Sanctuaries - National Parks - Tiger Reserves - Zoological Parks - Biosphere reserves. Wildlife Projects - Tiger - Elephant - Lion - Hangul. Role of Government and Non-Governmental organizations – UNEP – WCS - WII- BNHS - WWF. Central Zoo Authority of India.

**Learning Resources:**

**Text Books**

1. Balakrishnan, (2016). Wild life Ecology and Conservation, First Edition, Scientific Publishers, New Delhi.
2. Hosetti, B.D (2005). Concepts in Wild life Management, Daya Publishing House, New Delhi.

## References

1. Jani, R (2012). Basics of Wild Life healthcare and Management, First Edition, Narandra Publishing House, New Delhi.
2. Majupuria, T.C (1986). Wild life Wealth of India (Resource and Management) First Edition, Tech Press Service, Bangkok.
3. Ranga, M.M (2002). Wild life Management and Conservation, Agro bios, Jodhpur.
4. Woodroffe R, Thirgood, S and Rabinowitz A (2005). People and Wildlife, Conflict or Co existence. Cambridge University.

## Websites/ e-Learning Resources

1. <https://www.bbau.ac.in/dept/dz/TM/AS-302%20Wildlife%20and%20Conservation%20Biology.pdf>
2. <https://kalpavriksh.org/wp-content/uploads/2019/05/Human-wildlife-Conflicts-January-.2003.pdf>
3. [https://iscnagpur.ac.in/study\\_material/1.8\\_SAK\\_Conservations\\_of\\_Biodiversity\\_EX-SITU\\_IN\\_SITU%5B1%5D.pdf](https://iscnagpur.ac.in/study_material/1.8_SAK_Conservations_of_Biodiversity_EX-SITU_IN_SITU%5B1%5D.pdf)
4. <https://cpc.parivesh.nic.in/writereaddata/WildlifeProtectionAmendmentBill2013.pdf>
5. <https://digitalcommons.unl.edu/cgi/viewcontent>

## CO – PSO Mapping

CO/PSO	PSO 1	PSO 2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	2	2	3	3	3	2	2	3
CO 2	3	3	3	2	3	3	3	2	2	3
CO 3	3	3	2	2	3	3	3	2	2	3
CO 4	3	3	3	2	3	3	2	2	2	3
CO 5	3	3	2	2	3	3	2	2	2	3
Average	3	3	2.4	2	3	3	2.6	2	2	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-‘**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5204	Nanobiology	DSE	3	2

This course includes introduction to nanoscale, emergence and scope of Nanobiology approaches for synthesis and general properties of nanoparticles. It further covers aspects of nanomolecular tools and techniques, nanostructures, applications of bionanotechnology.

### Course Outcomes:

At the end of the course, the students will be able to:

**CO1:** Outline the nanoscale, scope of nanobiology, properties, and advantages of nanoscale molecules.

**CO2:** Discuss about biomolecules as model system and mechanical systems.

**CO3:** Explain about various uses of nano molecular tools and techniques.

**CO4:** Examine fabrication and applications of nanobiology in disease diagnosis and therapy.

**CO5:** Compare different natural bionano products and their applications in human health.

### UNIT I: (9 Hours)

**Introduction to Nanobiology:** Nanoscale – biology at nanoscale - emergence – Richard Feynman - ‘Top-Down’ & Bottom-Up’ approach - scope – molecules at nanoscale – general properties – advantages.

### UNIT II: (9 Hours)

**Nanostructures:** Biology as a model system for building nanostructures-proteins and oligonucleotides as ‘molecular glue’ – Single- and multi-strand DNA nanomotors – Micro Electro Mechanical Systems – Nano Electro Mechanical Systems.

### UNIT III: (9 Hours)

**Nanomolecular tools and techniques:** Fabrication and applications - Quantum dots (Chan and Nie’s method), Dendrimers (Divergent & Convergent methods), carbon

nanotubes (CVD, EAD, LA methods), Virus like particles – atomic Force microscopy – Confocal microscopy – SEM – TEM.

**UNIT IV: (9 Hours)**

**Applications in diagnosis and therapy:** Nanobiosensors - classes – diagnosis- bacterial UTI, HIV, Cancer – drug delivery – localized and targeted - controlled- enhanced circulation time & biodistribution - drug Solubility - intracellular delivery- cross biological Membranes - enhanced surface areas - activation and targeting through physico-chemical Stimuli – pH - thermal - tissue engineering.

**UNIT V: (9 Hours)**

**Bionanoproducts:** Nanogel (Glucose Sensitive)– nanosponge – bionanofabrics – milk silk – soya silk – spider silk – bioelectricity – biobatteries – biomimicry.

**Learning Resources:**

**Text Books:**

1. Gonsalves, KE. (2008). Biomedical Nanostructures. John Wiley & Sons Inc., Hoboken, New Jersey, United States of America.
2. Stroschio, MA and Dutta M. (2004). Biological Nanostructures and Applications of Nanostructures in Biology: Electrical, Mechanical, and Optical Properties. Kluwer Academic Publishers, New York, USA.

**References**

1. Niemeyer, CM and Mirkin, CA (2004). Nanobiotechnology. I. Concepts, Applications and Perspectives. Wiley-VCH, Verlag GmbH & Co., Weinheim.
2. Mirkin CA and Niemeyer CM (2007). Nanobiotechnology II: more Concepts and Applications, Wiley-VCH, Verlag, GmbH & Co., Weinheim.
3. Miller JC, Serrato R, Represas-Cardenas JM and Kundahl G (2005). The Handbook of Nanotechnology. John Wiley & Sons, Inc. Hoboken, New Jersey, USA.
4. Shawn A (2009). A – Z Nanobiology. First Edition, Centrum Press, New Delhi.
5. Goodsell DS (2004). Biotechnology: lessons from nature. Wiley-Liss, Inc., Hoboken, New Jersey, United States of America.

6. Gazit E (2007). Plenty of Room for Biology at the Bottom: An Introduction to Bio-nanotechnology. Imperial College Press, London.
7. Vo-Dinh T (2007). Nanotechnology in biology and medicine: methods, devices, and applications. CRC Press Taylor & Francis Group, Florida.

**Websites/e-Learning resources:**

1. [http://materials.globalspec.com/LearnMore/Materials\\_Chemicals\\_Adhesives/Electrical\\_Optical\\_Specialty\\_Materials/Nanomaterials\\_Nanotechnology\\_Products](http://materials.globalspec.com/LearnMore/Materials_Chemicals_Adhesives/Electrical_Optical_Specialty_Materials/Nanomaterials_Nanotechnology_Products).
2. <https://nanohub.org/groups/education>

**CO – PSO Mapping**

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	1	3	2	2
CO2	3	3	3	3	3	2	2	3	2	3
CO3	3	3	3	3	3	3	2	3	3	3
CO4	3	3	3	3	3	3	2	3	3	3
CO5	3	3	3	3	3	2	2	3	3	3
Average	3	3	3	3	3	2.4	1.8	3	2.6	2.8

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5601	Project	Core	6	6

This course deals with research projects in various fields of life sciences. It enables the students in the preparation of research proposal publish research articles and defending research work.

### Course Outcomes

At the end of the course, students will be able to:

**CO1:** Identify and formulate research problem.

**CO2:** Review and survey the literature from related journals.

**CO3:** Discuss and execute the research project.

**CO4:** Interpret results and preparation of report.

**CO5:** Analyse data and publish in reputed journals.

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	2	2	3	3
CO2	3	3	3	3	3	3	2	2	3	3
CO3	3	3	3	3	3	3	2	2	3	3
CO4	3	2	3	3	3	3	2	2	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Average	3	2.8	3	3	3	3	2.2	2.2	3	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ5244	Professional Competency Skill	SEC	-	2

This course gives a thrust in developing confidence to face competitive exams. It creates base line aptitude for entering into various jobs and clearing the competitive examinations. It helps to develop competencies in various fields of Life science.

### Course Outcomes

At the end of the course, the students will be able to:

**CO1:** Develop an in depth knowledge on core concepts of Zoology.

**CO2:** Recognize the aptitude to pass competitive examinations.

**CO3:** Relate the skills to clear competitive examinations.

**CO4:** Practice for competitive examination.

**CO5:** Convert the learning skills to achieve success in competitive examination.

### CO – PSO Mapping

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	3	2	2	1	3	3	3	3	3
CO 2	3	3	2	2	2	3	3	2	3	3
CO 3	3	3	1	2	1	3	3	2	3	3
CO 4	3	3	2	2	2	3	3	3	3	3
CO 5	3	3	1	1	1	3	3	2	3	3
Total	15	15	8	9	7	15	15	12	15	15
Average	3	3	1.6	1.8	1.2	3	3	2.4	3	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

**Department of Zoology (PG)**

**Value Added Courses**

**w.e.f. 2024-2025**

<b>Sem</b>	<b>Course Code</b>	<b>Course Title</b>	<b>Hours/Wk</b>	<b>Credits</b>
2	24PGZ422V	Ornamental Fish Culture	2	2
4	24PGZ521V	Fishery Products	2	2

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ422V	Ornamental Fish Culture	VAC	2	2

This course deals with the principle and practices of ornamental fish culture. It includes the diverse range of freshwater and marine ornamental fish, their biology, breeding, nutritional needs and disease management. It provides alternative livelihood opportunities and entrepreneurial skills.

**Course Outcome:**

At the end of the course, students will be able to:

**CO 1:** Identify the exotic, indigenous and endemic species of aquarium fish.

**CO2:** Design the key skills needed to set up an aquarium.

**CO3:** Describe the biology and the breeding habits of ornamental fishes.

**CO4:** Formulate the fish feed, nutritional benefits and health management

**CO 5:** Discuss the maintenance and transportation of aquarium fishes.

**UNIT I: (6 Hours)**

**Introduction to Ornamental Fish Farming:** Origin and history of fish keeping- scope of aquarium fish farming as a cottage industry. Exotic - indigenous- endemic species – invasive species - advantages.

**UNIT II: (6 Hours)**

**Aquarium keeping:** Types of Aquaria – salinity - temperature range and species selection-Marine and freshwater aquaria. Aquarium setup and accessories - Filters - filtration methods (Mechanical, Chemical & Biological) – Aerators - lighting, Biofilters - Precautions and criteria selection for an ideal aquarium fishes.

**UNIT III: (6 Hours)**

**Biology of Aquarium Fishes:** Common characters - sexual dimorphism of Fresh, brackish and Marine Aquarium fishes - Guppy - Gold fish - Angel fish - Black Molly- Sword tail - Ray fish - Anemone fish - Moorish idol - Butterfly fish - Breeding habits.

**UNIT IV: (6 Hours)**

**Food, Feeding, nutrition and diseases of Aquarium Fishes:** Preparation - composition of fish feeds- Qualities-nutritional requirements - Live feed culture for fishes (*Artemia sp.*). Aquarium Fish Diseases- Parasitic (Whirling disease) - Bacterial (Fin Rot disease) - Viral (*Lymphocystis*) - Protozoan (White spot disease) - Fungal diseases (*Saprolegniasis*).

**UNIT V: (6 Hours)**

**Packing, Transportation and Economics:** Water quality -maintenance - temperature control. Live fish transport – packing – conditioning - transport - quarantine methods - factors and principles - Budget to set up an aquarium.

**Learning Resources:**

**Text Book**

1. Yadav BN (2006). Fish and fisheries. 4<sup>th</sup> Edition. Daya Publishing house, New Delhi.

**References**

1. Santhanam, P., Sukumaran, N. & P. Natarajan (1987). A manual of freshwater aquaculture, Oxford & IBH Publishing Company Pvt., Ltd., New Delhi.
2. Cliff Harrison (1980). A color guide to Tropical Fish, Chartwell Books, INC, Cerkshire, printed in Hon Kong.
3. Dick Mills (1987). Illustrated Guide to Aquarium Fishes. Published by Galley and Price, an imprint of W.H. Smith and Sons Limited, England.
4. Jingran V.G (1991). Fish and Fisheries in India – Hindustan Publ.co. New Delhi
5. Jayashree K. V., Tharadevi C. S., and Arumugam N (2015). Home Aquarium and Ornamental Fish Culture, Saras Publication, Tamil Nadu, India

**Web Resources / e-Learning Resources**

1. [https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004150935214277spt\\_rivedi\\_MAINTENANCE\\_OF\\_FISHES.pdf](https://www.lkouniv.ac.in/site/writereaddata/siteContent/202004150935214277spt_rivedi_MAINTENANCE_OF_FISHES.pdf)
2. [https://prgc.ac.in/uploads/study\\_material/Ornamental%20fisheries-converted.pdf573.pdf](https://prgc.ac.in/uploads/study_material/Ornamental%20fisheries-converted.pdf573.pdf)

3. <https://www.fao.org/4/ac182e/AC182E04.htm>
4. <https://elearning.raghunathpurcollege.ac.in/files/4B9DCF9D16060599490.pdf>
5. <https://www.aqueon.com/articles/aquarium-disease-prevention>
6. <https://www.aquariumindustries.com.au/wp-content/uploads/2015/04/Common-Fish-Disease-Symptoms-Poster.pdf>

### CO – PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	3	3	3	2	2	3	3	3	3
CO 2	3	3	3	3	2	2	3	3	3	3
CO 3	3	3	3	3	2	2	3	3	3	3
CO 4	3	3	3	3	2	2	3	3	3	3
CO 5	3	3	3	3	2	2	3	3	3	3
Average	3	3	3	3	2	2	3	3	3	3

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24PGZ521V	Fishery Products	VAC	2	2

This course describes about fish handling and preservation techniques. This course also deals with the fish products, value added products, quality control, packaging and certification.

### Course Outcome

At the end of the course, the students will be able to:

**CO 1:** Acquire knowledge in fish handling and preservation techniques.

**CO 2:** Identify value-added products from fish.

**CO 3:** Outline the various fish products and their importance.

**CO 4:** Examine the methods of quality control and packaging.

**CO 5:** Apply the knowledge on quality management and certification.

### UNIT I: (6 Hours)

**Fish processing and preservation:** Handling - transport - storage of fresh fish - sanitary requirements - Fish preservation - curing -sun drying - artificial drying - wet and dry salting - smoking - chilling - freezing & canning.

### UNIT II: (6 Hours)

**Value added products from fish:** fish pickles - sauce - oil - wafers - soup powder -- extrusion - moulded product - formulated products - burger - cutlet – surimi - ready to eat - battered and breaded products.

### UNIT III: (6 Hours)

**Fish byproducts:** Fish protein concentrate - fish maws – Isinglass - cod liver oil - fish hydrolysates – chitin - chitosan - Glucosamine hydrochloride - Gelatin - fish silage – mince - kamaboko products - pearl essence.

### UNIT IV: (6 Hours)

**Packaging aspect of fishery products:** Identification of freshness - spoilage of dried and cured fish - rigor mortis - autolysis - rancidity - spoilage control methods -

extension of shelf life. Packaging materials - freezing and canning industry - lacquered can - plastic laminated carton - retort pouch - MAP - vacuum packaging.

#### **UNIT V:**

**(6 Hours)**

**Quality management, marketing and certification:** Hazard analysis and critical control point (HACCP) - Agencies involved in marketing- Good manufacturing practices - Codex Alimentarius System- Food Safety and Standards Act of India, 2006 - NFDB - CIFRI -MPEDA.

#### **Learning Resources:**

##### **Text Books**

1. Balachandran, K.K (2001). Post-Harvest Technology of Fish and Fish Products. Daya Publishing house, Delhi.
2. Sen, D.P (2005). Advances in Fish Processing Technology, Allied Publisher and Pvt. Ltd. Hyderabad.

##### **References**

1. John, D.E.V (1985). Food Safety and Toxicity, CRC Press, U.S.
2. Mohan, C. O., Elavarasan, K., Sreejith, S. and Sreelakshmi, K. R (2021). Thermal processing of fish, *In: Fish and Marine Products Processing*, Central institute of Fisheries Technology, Cochin.

##### **Websites/ e-Learning Resources**

1. <http://ecoursesonline.iasri.res.in/course/view.php?id=287>
2. [https://elearning.icar.gov.in/eLearning\\_ContentDisplayUG.aspx?](https://elearning.icar.gov.in/eLearning_ContentDisplayUG.aspx?)
3. <http://courseware.cutm.ac.in/courses/fish-byproducts-and-waste-utilization/>
4. <https://www.slideshare.net/slideshow/fish-by-products-by-umaiya-farooq/72776680>

### CO – PO Mapping

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	1	3	2	2	1	2	3	3
CO 2	3	3	1	2	1	3	2	2	2	3
CO 3	3	2	2	3	3	2	2	3	2	3
CO 4	2	3	3	2	2	2	2	3	3	2
CO 5	3	1	2	3	3	2	1	2	3	3
Average	2.8	2.2	1.8	2.6	2.2	2	1.6	2.4	2.6	2.8

**High correlation – 3, Medium correlation – 2, Low correlation – 1, No correlation - ‘-’**