Manonmaniam Sundaranar University

Tirunelveli

M.Sc., Zoology Syllabus

(From 2026-2027 Onwards)

Contents

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK FOR POSTGRADUATE EDUCATION	
Programme	**M.Sc., Zoology**
Programme Code	
Duration	**PG-2 years**
Programme Outcomes (POs)	After successful completion of the Postgraduate Programme in Zoology, the learner will be able to: **PO1 – Scientific Knowledge** Acquire and comprehend advanced knowledge in various branches of Zoology and allied biological sciences. **PO2 – Analytical and Problem-Solving Skill** Analyze biological problems critically and apply scientific approaches to provide suitable solutions. **PO3 – Research Aptitude** Apply research methodologies, laboratory techniques and statistical tools in biological investigations and scientific studies. **PO4 – Communication and Digital Skill** Demonstrate effective scientific communication skills and utilize digital technologies and bioinformatics tools in learning and research. **PO5 – Ethical and Environmental Awareness** Adopt ethical principles, environmental sustainability and social responsibility in personal and professional practices. **PO6 – Leadership and Teamwork** Develop leadership qualities, teamwork and interpersonal skills for collaborative learning and professional competence. **PO7 – Lifelong Learning and Employability** Engage in lifelong learning and acquire employability and entrepreneurial skills relevant to academia, research and industry.

Programme Specific Outcomes (PSOs)	After successful completion of the Programme, the learner will be able to: **PSO1 – Taxonomic and Biodiversity Knowledge** Demonstrate comprehensive knowledge on animal diversity, taxonomy, evolution and conservation biology. **PSO2 – Laboratory and Technical Skill** Perform advanced laboratory techniques and experimental procedures in Zoology and interdisciplinary biological sciences. **PSO3 – Research and Innovation** Design and conduct independent research studies using scientific methods and modern analytical tools. **PSO4 – Environmental and Conservation Competency** Apply ecological principles and conservation strategies for biodiversity management and environmental sustainability. **PSO5 – Molecular and Applied Biological Skill** Utilize molecular biology, biotechnology and bioinformatics approaches in biological research and applied sciences. **PSO6 – Professional and Ethical Competency** Exhibit professional ethics, scientific integrity and effective communication in academic, research and societal activities. **PSO7 – Employability and Entrepreneurship** Develop employability, leadership and entrepreneurial competencies for careers in teaching, research, industry and allied sectors.

Programme Details

Eligibility Criteria

Those who have passed B.Sc. Zoology, B. Sc. Advanced Zoology, B.Sc. Applied Zoology, B.Sc. Animal Science and Biotechnology, B.Sc. Advanced Zoology and Biotechnology, B.Sc. Life Science and B.Sc. Biology (Hon.) from recognized university.

Medium of Instruction

English

Duration of the Programme

Two years (Four semesters)

Examination Scheme

Theory Examination:

The M.Sc. Zoology Core Theory Examination having the following marks.

METHODS OF EVALUATION for THEORY		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Snap Test	
	Quiz Seminars	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	100 Marks

METHODS OF EVALUATION for Internship/Industrial/Field visit		
Internal Evaluation	Attendance	50 Marks
	Report	
	Activity	
External Evaluation	End Semester Evaluation	50 Marks
	Total	100 Marks

Note: -

*Internship/ Industrial visit/ Field visit/ Research Knowledge updating activity (Internal: 50 Marks, External: 50 Marks).

*A report should be submitted at the end of III – semester and evaluated by the external examiners (External – 50 Marks).

*Internship students should submit certificate of attendance from the authorities concerned along with report (External – 50 Marks)

*Internship programme should be executed for a minimum tenure of 10 days in a non-parental institute / recognized scientific laboratory/ Governmental/ Non-Governmental organization under the supervision of the head of the concerned Institution

METHODS OF EVALUATION for Extension activities and Project		
Internal Evaluation	Attendance	50 Marks
	Report	

	Activity	
External Evaluation	End Semester Evaluation Viva –voce	50 Marks
	Total	100 Marks

Note:-

Extension activities

- Internal: 50 Marks, External: 50 Marks (Total: 100 Marks)
- Individual report should be submitted at the end of IV – semester.
- External 50 marks will be evaluated by the external examiners.
- Extension activities to be done in groups, each having maximum of 4 members.

***Project viva – voce examination**

- Internal: 50 Marks, External: 50 Marks (Total: 100 Marks)
- Individual dissertation should be submitted
- External 50 Marks will be evaluated by the external examiners.

Practical Examination:

M.Sc Zoology core Practical Examination having the following marks:

Internal - 50

Major Practical =	15 marks
Minor Practical =	10 marks
Spotters (A, B, C &D) 4x1 =	20 marks
Regular practical assessment = and record	5 marks
Total =	50 marks

External – 50

Major Practical =	15 marks
Minor Practical =	10 marks
Spotters (ABC&D) 4x5 =	20 marks
Field visit / Record =	5 marks
Total =	50 marks

Question paper pattern

External Examination - 75

Section A: 10x 1 (Q. No. 1 to 10) = 10 marks

Section B: 5 x 5 (Q. No. 11 to 15) = 25 marks

Section C: 5 x 8 (Q. No. 16 to 20) = 40 marks

Total = 75 marks

Note: 40% questions to be taken from K1, K2 & K3 and 60% questions to be taken in K4, K5 & K6

Model Question Paper

END SEMESTER EXAMINATIONS

MSc Zoology

MODEL QUESTION PAPER

Core Course – I Structure and Function in Invertebrates

Time: 3 Hours **Maximum Marks: 75**

Section A

Choose the correct answer **10 * 1 = 10**

1. DNA barcoding is primarily based on **(K1)**
   a) Protein analysis
   b) Morphological characters
   c) Mitochondrial DNA sequences
   d) Fossil records
2. Cladistics is mainly concerned with **(K1)**
   a) Ecology
   b) Evolutionary relationships
   c) Physiology
   d) Anatomy
3. Animals lacking a body cavity are called **(K1)**
   a) Coelomates
   b) Acoelomates

c) Pseudocoelomates

d) Deuterostomes

4. Locomotion in Protozoa is commonly achieved by **(K1)**

a) Nephridia

b) Tracheae

c) Flagella and cilia

d) Gills

5. Filter feeding is common in **(K1)**

a) Polychaeta

b) Mollusca

c) Echinodermata

d) All of the above

6. Hemocyanin contains **(K1)**

a) Iron

b) Copper

c) Magnesium

d) Calcium

7. Malpighian tubules are excretory organs of **(K1)**

a) Annelids

b) Insects

c) Molluscs

d) Echinoderms

8. The most advanced nervous system among molluscs occurs in **(K1)**

a) Gastropoda

b) Bivalvia

c) Cephalopoda

d) Scaphopoda

9. Trochophore larva is characteristic of **(K1)**

a) Annelida

b) Porifera

c) Cnidaria

d) Nematoda

10. Peripatus belongs to **(K1)**

a) Echiura

b) Rotifera

c) Sipuncula

d) Onychophora

Section B

Answer ALL the questions **5 * 5 = 25**

11 (a) Explain the species concept and its significance. **(K2)**

(OR)

(b) Describe the important taxonomic procedures used in classification. **(K2)**

12 (a) Differentiate between acoelomates and pseudocoelomates. **(K3)**

(OR)

(b) Illustrate on hydrostatic movement in Annelida. **(K3)**

13 (a) Discuss the feeding patterns in lower metazoans. **(K3)**

(OR)

(b) Describe the structure and functions of gills **(K3)**

14 (a) Justify Malpighian tubules as excretory organs **(K4)**

(OR)

(b) Comment on osmoregulation in invertebrates. **(K4)**

15 (a) Write a short note on Rotifera. **(K2)**

(OR)

(b) Describe the larval forms of parasitic invertebrates. **(K2)**

Section C

Answer ALL the questions **5 * 8 = 40**

16 (a) Evaluate the advantages and limitations of traditional taxonomy and molecular taxonomy in the classification of invertebrates **(K6)**

(OR)

(b) Assess the role of DNA barcoding in resolving taxonomic ambiguities among invertebrate species. **(K6)**

17 (a) **Infer** the evolutionary significance of coelom development in the diversification of animal phyla. **(K6)**

(OR)

(b) Differences between Protostomia and Deuterostomia in its structure, function and their evolutionary implications. **(K6)**

18 (a) **Assess** the adaptive significance of various respiratory organs and respiratory

pigments in invertebrates. **(K5)**

(OR)

(b) Evaluate the efficiency of different feeding and digestive mechanisms among lower metazoans in relation to their habitats. **(K5)**

19 (a) **Construct** a hypothetical evolutionary pathway showing the transition from primitive nerve nets to highly centralized nervous systems in invertebrates. **(K6)**

(OR)

(b) Evaluate the effectiveness of different excretory organs in maintaining osmotic balance in aquatic and terrestrial invertebrates **(K6)**

20 (a) **Enumerate** the evolutionary significance of larval forms in the survival, dispersal, and diversification of invertebrates. **(K5)**

(OR)

(b) Elaborate the taxonomic position and phylogenetic importance of minor phyla such as Rotifera, Sipuncula, Echiura, and Onychophora. **(K5)**

First Year: Semester-I

Part	List of Courses	Credits	No. of Hours/ week	Total hours/ Semester	nternal marks	xternal marks	Total marks
Core Course – I	Structure and Function of Invertebrates	5	6	90	25	75	100
Core Course – II	Comparative Anatomy of Vertebrates	5	6	90	25	75	100
Core Course –III	Lab Course in Invertebrates & Lab Course in Vertebrates	2	4	60	50	50	100
Elective Course – I	Biochemistry	3	5	75	25	75	100
Elective Course – II	Sericulture	3	5	75	25	75	100
Elective Course - III	Lab course in Biochemistry & sericulture	2	4	60	50	50	100
		20	**30**	**450**			

First Year: Semester-II

Part	List of Courses	Credits	No. of Hours/ week	Total hours/ Semester	nternal marks	xternal marks	Total marks
Core – IV	Genetics	5	5	75	25	75	100
Core – V	Developmental Biology	5	5	75	25	75	100
Core – VI	Lab Course in Genetics & Developmental Biology	2	4	60	50	50	100
Elective– IV	Biostatistics	3	4	60	25	75	100
Elective– V	Research Methodology	3	4	60	25	75	100

Skill Enhancement Course [SEC] – I	Entomology	2	4	60	25	75	100
Elective Course – VI	Lab course in Biostatistics & Research Methodology	2	4	60	50	50	100
		22	**30**	**450**			

Second Year – Semester – III

Part	**List of Courses**	**Credits**	**No. of Hours/ week**	**Total hours/ semester**	**Internal marks**	**External marks**	**Total marks**
Core – VII	Cell & Molecular Biology	6	6	90	25	75	100
Core – VIII:	Animal Physiology	5	6	90	25	75	100
Core – IX	Lab in Cell & Molecular Biology and Animal Physiology	2	4	60	50	50	100
Elective – VII	Evolution	4	4	60	25	75	100
Elective – VIII	Applied Biotechnology	4	4	60	25	75	100
Skill Enhancement Course – II	Apiculture	2	4	60	25	75	100
Elective Course - IX	Lab course in Evolution & Biotechnology	1	2	30	50	50	100
Internship	* Internship / Industrial Activity /Field visit/ Research – knowledge updating	2	-	-	50	50	100

	activity [Credits]						
Total		**26**	**30**	**450**			

Second Year – Semester – IV

Part	**List of Courses**	**Credits**	**No. of Hours**	**Total hours**	**Internal marks**	**External marks**	**Total marks**
Core – XI	Immunology	5	5	75	25	75	100
Core – XII	Ecology	5	5	75	25	75	100
Core –XIII	Lab course in Immunology & Ecology	2	4	60	50	50	100
Elective – X	Microbiology	3	4	60	25	75	100
Skill Enhancem ent Course – III	Aquaculture	2	4	60	25	75	100
Elective - XI	Lab course in Microbiology & Aquaculture	1	2	30	50	50	100
	#Extension Activity	1	-	-	50	50	100
	***Project**	4	6	90	50	50	100
		23	**30**	**450**			

Course PSO Mapping

Core Course	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
Structure and Function of Invertebrates	10	9	9	10	8	9	6
Comparative Anatomy of Vertebrates	10	9	9	10	8	9	6
Lab Course in Invertebrates & Lab Course in Vertebrates	9	11	9	10	8	9	6
Biochemistry	8	10	9	8	12	9	6
Sericulture	8	11	9	11	8	9	8
Lab course in Biochemistry & sericulture	12	12	12	10	12	9	12
Genetics	12	8	11	8	12	9	10
Developmental Biology	10	10	10	10	8	8	6
Lab Course in Cell Biology & Developmental Biology	12	12	12	12	8	9	8
Biostatistics	10	12	12	8	9	8	8
Research Methodology	8	12	12	10	10	9	7
Entomology	10	9	9	11	8	9	8
Lab course in Biostatistics & Research Methodology	10	12	12	10	10	9	11
Cell & Molecular Biology	10	9	9	10	8	9	6
Animal Physiology	10	10	12	9	11	9	8
Lab in Cell & Molecular Biology and Animal Physiology	12	12	12	12	8	9	8
Evolution	10	8	10	10	10	8	9
Applied Biotechnology	10	8	12	11	12	12	10
Apiculture	10	9	12	10	11	9	12
Lab course in Evolution & Biotechnology	10	12	12	10	12	9	10
Immunology	8	10	9	8	12	9	6
Ecology	11	7	9	11	8	9	6
Lab course in Immunology & Ecology	8	11	9	9	9	9	6
Microbiology	10	12	12	12	12	11	9
Aquaculture	8	10	9	10	8	9	8
Lab course in Microbiology & Aquaculture	12	12	12	10	8	9	12

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	STRUCTURE AND FUNCTION OF INVERTEBRATES	**CORE**	**6**	**-**	**-**

Pre-requisite:

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

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement	K Level
CO1	Understand taxonomy, body organization, physiology, larval forms and general characteristics of invertebrates.	K1 & K2
CO2	Apply concepts of classification, physiology and developmental adaptations in invertebrates.	K3
CO3	Analyze evolutionary trends and functional organization in invertebrate groups.	K4
CO4	Evaluate phylogenetic relationships and formulate evolutionary interpretations in invertebrates.	K5 & K6

Unit I

Structure and function in invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; **New trends in taxonomy: Molecular taxonomy, DNA barcoding, cladistics, and phylogenetic systematics taxonomy.**

Unit II

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

Unit III

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

Unit IV

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

Unit V

Invertebrate larvae: Larval forms of free-living invertebrates - Larval forms of parasites; Strategies and Evolutionary significance of larval forms. **Organization and general characters of Minor Phyla: Rotifera, Sipuncula, Echiura, Onychophor**

Reading list

1. Barrington, E. J.W. 1979. Invertebrate Structure and Function. The English Language Book Society and Nelson, pp-765.

Recommended texts

1. Barnes, R. D. 1974. Invertebrate Zoology, (Second Edition), Holt-Saunders International Edition, pp-1024.

2. Barnes, R. S. K., P. Calow, P. J. W. Olive, D. W. Golding, J. J. Spicer. 2013. The Invertebrates: A Synthesis. Third Edition. John Wiles & Sons Inc., Hoboken. New Jersey, New Delhi.

3. Dechenik, J. A. 2015. Biology of Invertebrates (Seventh Edition). Published by McGraw Hill Education (India) Private Limited, pp-624.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	1	1
CO2	3	3	2	2	2	2	1
CO3	2	3	3	2	2	2	2

CO4	**2**	**3**	**3**	**3**	**3**	**2**	**2**
Total Score	**10**	**11**	**9**	**8**	**9**	**7**	**6**

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	**3**	**1**	**1**	**2**	**1**	**2**	**1**
CO2	**3**	**2**	**2**	**2**	**2**	**2**	**1**
CO3	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO4	**2**	**3**	**3**	**3**	**3**	**3**	**2**
Total Score	**10**	**9**	**9**	**10**	**8**	**9**	**6**

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	COMPARATIVE ANATOMY OF VERTEBRATES	**CORE**	**6**	**-**	**-**

Course Outcomes (COs)

Upon completion of this course, students could

CO	Course Outcome Statement	K Level
CO1	Explain vertebrate origin, integumentary structures, circulatory systems, skeletal organization and nervous systems.	K1 & K2
CO2	Apply comparative morphological and physiological concepts in vertebrate classification and functional adaptations.	K3
CO3	Analyze evolutionary trends and structural modifications in vertebrate organ systems.	K4
CO4	Evaluate phylogenetic relationships and formulate evolutionary interpretations of vertebrate morphology and organ systems.	K5 & K6

Unit I

Origin of vertebrates: Concept of Protochordata; The nature of vertebrate morphology; **scope and significance of vertebrate morphology; molecular and evolutionary approaches in vertebrate morphology**; Importance of the study of vertebrate morphology.

Unit II

Origin and classification of vertebrates; Vertebrate integument and its derivatives. Development, **General structure and functions of Skin derivatives and their adaptive significance; Pigmentation, chromatophores and colouration in vertebrates.**

Unit III

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

Unit IV

Skeletal system: Form, function, body size and skeletal elements of the body; Comparative accounlopt of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of

Urinogenital system in vertebrate series. **Adaptive radiation of limbs and Aquatic skeletal adaptations**

Unit V

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

Reading list

1. Swayam Prabha https://www.swayamprabha.gov.in/index.php/program/archive/9
2. Yong, J. Z. 1981. The life of Vertebrates, English language Book society, London, pp-645.
3. Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia, pp-600.

Recommended texts

1. Waterman, A.J. 1972. Chordate Structure and Function, MacMillan Co., New York, pp.587.
2. Parker T. J. and W. A. Haswell. 1962. A text book of Zoology, Vol. 2, Vertebrates, 7th Edition, Mac Millan Press, London, pp-750.
3. Ekambaranatha Ayyar and T. N. Ananthakrishnan. 2009. Manual of Zoology, Vol – II, S. Viswanathan Pvt. Ltd. Chennai.
4. Kotpal, 2019. R.L. Modern Text Book of Zoology Vertebrates, 4th Edition, Rastogi Publications, Meerut, pp-968.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	2	1	1
CO2	3	3	2	2	2	2	1
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	3	2	2
Total Score	10	11	9	8	9	7	6

Level of Correlation

3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	2	1	2	1
CO2	3	2	2	2	2	2	1
CO3	2	3	3	3	2	2	2
CO4	2	3	3	3	3	3	2
Total Score	10	9	9	10	8	9	6

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	LAB COURSE IN INVERTEBRATES & VERTEBRATES	**CORE**	**-**	**4**	**-**

Pre-requisite:

Students should possess basic knowledge of animal taxonomy, anatomy, physiology, microscopy, dissection techniques and laboratory safety procedures for effective understanding of zoological practical exercises.

Course Outcomes (COs)

Upon completion of this course, students could

CO	Course Outcome Statement	K Level
CO1	Identify and remember the morphology, anatomy and diagnostic characters of selected invertebrates and chordates.	K1 & K2
CO2	Apply dissection, mounting and specimen preservation techniques in practical zoology.	K3
CO3	Analyze structural adaptations, nervous systems and functional morphology of representative animal forms.	K4
CO4	Evaluate comparative anatomical features and interpret evolutionary relationships among invertebrates and chordates.	K5 & K6

INVERTEBRATES

Dissection / Virtual

Earthworm : Nervous system

Cockroach : Nervous system

Grasshopper : Digestive system and mouth parts

Prawn : Appendages, nervous and digestive systems

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

1. Amoeba
2. Entamoeba histolytica
3. Paramecium

4. Hydra with bud
5. Sporocyst – Liver fluke
6. Cercaria larva
7. Tape worm (Scolex)
8. Ascaris T. S.
9. Mysis of prawn

Spotters

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

Mounting

Earthworm : Body setae

Pila : Radula

Cockroach : Mouth parts

Grasshopper : Mouth parts

CHORDATES

Study the nervous system of Indian dog shark – Dissection / Virtual

1. Nervous system of Scoliodon laticaudatus – 5th or Trigeminal nerve

2. Nervous system of Scoliodon laticaudatus – 9th and 10th or Glossopharyngeal & Vagus nerve

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

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

12. Tetrodon punctatus (Puffer fish)
13. Dendrophis sp. (Tree snake)

Study of the different types of scales in fishes

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

Study of the frog skeleton system (Representative samples) 1. Entire skeleton 2. Skull

Text Books:

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

Reference Books:

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

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	2	2	1
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	3	2	2
Total Score	10	11	9	8	8	8	6

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	1	2	1	2	1
CO2	2	3	2	2	2	2	1

CO3	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO4	**2**	**3**	**3**	**3**	**3**	**3**	**2**
Total Score	**9**	**11**	**9**	**10**	**8**	**9**	**6**

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	BIOCHEMISTRY	**ELECTIVE**	**5**	**-**	**-**

Pre-requisite:

Students should Understand the fundamental properties of elements, atoms, molecules, chemical bonds, linkages and structure, composition, metabolism and functions of biomolecules.

Course Outcomes (COs)

Upon completion of this course, students could

CO	Course Outcome Statement	K Level
CO1	Remember the fundamentals of biophysical chemistry, biomolecules, bioenergetics and structural organization of proteins and nucleic acids.	K1 & K2
CO2	Apply principles of biophysical chemistry, enzymology and biomolecular interactions in biological systems**.**	K3
CO3	Analyze metabolic pathways, enzyme kinetics and structural conformations of biomolecules.	K4
CO4	Evaluate stability, functional significance and molecular interactions of biological macromolecules.	K5 & K6

Unit I

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

Unit II

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

Unit III

Bioenergetics and enzymology: Bioenergetics, glycolysis, **Electron transport chain**, Oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers -

Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isoenzymes

Unit IV

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

Unit V

Metabolic regulation and integration; Biochemical role of vitamins, coenzymes and cofactors. Stability of protein and nucleic acid structures; protein folding; Metabolic disorders and biochemical basis of diseases.

Reading list

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

Recommended texts

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

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	1	2	1
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	2	2	2
Total Score	10	11	9	8	6	8	6

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	1	1	3	2	1
CO2	2	3	2	2	3	2	1
CO3	2	3	3	2	3	2	2
CO4	2	2	3	3	3	3	2
Total Score	8	10	9	8	12	9	6

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	SERICULTURE	**ELECTIVE**	**5**	**-**	**-**

Pre-requisite:

Students should be aware of economic and cultural importance of sericulture.

Course Outcomes (COs)

Upon completion of this course, students could

CO	Course Outcome Statement	K Level
CO1	Understand and remember the types of textile fibers, biology of silkworm, host plants, sericulture practices and silkworm diseases.	K1 & K2
CO2	Apply techniques involved in mulberry cultivation, silkworm rearing, grainage technology and cocoon processing.	K3
CO3	Analyze the physiology, hormonal regulation, disease management and commercial aspects of sericulture	K4
CO4	Evaluate modern sericulture practices, silk production technologies and management strategies for sustainable silk industry development.	K5 & K6

Unit I

Introduction to textile fibers; types- natural and synthetic fibers; sources of silk fiber- Tasar, Muga, Anaphe, Gonometa, Fagara, spider and mussel; properties and importance of silk fiber. History, development, status, characteristics and advantages of sericulture in India.

Unit II: Host plants; Moriculture- distribution, morphology, propagation- seedling, cutting, grafting, layering and micropropagation methods, maintenance- irrigation, manuring and pruning, pests and diseases of mulberry.

Unit III

Biology and physiology of *Bombyx mori*; Races and voltinism. Structure of egg, larva, pupa and adult. Sexual dimorphism- larva, pupa and adult. Silk gland – Structure and Significance- Silk protein. Neuroendocrine system, neuro secretary cells, Corpora allata, Corpora cardiaca,

ecydysial gland. Hormonal control of moulting and metamorphosis. Exocrine glands and pheromones.

Unit IV

Grainage technology: Breeding Stations - methods of industrial egg production, mother moth examination, diapausing and non-diapausing eggs. Incubation and transport of eggs. Silk worm - Rearing: Rearing House (CSB- model) and Rearing appliances. Rearing operation- Disinfection, brushing, maintenance of optimum conditions, feeding, bed cleaning, spacing, care during moulting, mounting, and Harvesting. Rearing methods: Chawki rearing and rearing of late age and mature larvae- Mounting practices.

Unit V

Physical and commercial characteristics of cocoons. **Cocoon harvesting, processing and marketing**. By-products of sericulture industry. Reeling operation: reeling appliances- types - raw silk – raw silk testing. Diseases of Silkworm: Fungal, Viral, Bacterial diseases; Pest of silkworm – Uzi fly and Dermestid beetles - causative agent, symptoms, prevention and control measures.

Reading list

1. G. Ganga and J. Sulochana Chetty. 2019. An introduction to sericulture, 2nd edition, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
2. M. Johnson and M. Kesary. 2019. Sericulture, Saras publication, Tamilnadu.
3. Singh, Amardev & Ravinder Kumar. 2013. Sericulture handbook Vol 1, Biotech.
4. M. Madan Mohan Rao. An Introduction to Sericulture, 2nd edition, BS Publications.

Recommended websites

1. https://agritech.tnau.ac.in/sericulture/
2. https://csb.gov.in/

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	2	2	2
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	3	2	3
Total	10	11	9	8	8	8	8

Score							

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	**2**	**2**	**1**	**2**	**1**	**2**	**1**
CO2	**2**	**3**	**2**	**3**	**2**	**2**	**2**
CO3	**2**	**3**	**3**	**3**	**2**	**2**	**2**
CO4	**2**	**3**	**3**	**3**	**3**	**3**	**3**
Total Score	**8**	**11**	**9**	**11**	**8**	**9**	**8**

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

COURSE	COURSE NAME	CATEGORY	L	P	T

CODE					
	LAB COURSE IN BIOCHEMISTRY & SERICULTURE	**ELECTIVE**	**-**	**4**	**-**

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the principles of biochemical activity and its estimation, chromatographic separation, silkworm morphology, rearing practices, sericulture products, and diseases of silkworm and mulberry
CO2 (K3)	Apply biochemical and sericultural techniques to determine enzyme activity, estimate proteins and carbohydrates, separate amino acids chromatographically, perform dissections, and recognize sericulture appliances and products.
CO3 (K4)	Analyze the effects of substrate and enzyme concentration on enzymatic activity, interpret biochemical assay results, distinguish silkworm developmental stages, and identify diseases affecting silkworms and mulberry plants.
CO4 (K5 & K6)	Evaluate biochemical experimental data and sericulture practices, and develop scientific interpretations for enzyme kinetics, biomolecule estimation, silkworm health management, and sustainable silk production.

Biochemistry Practicals

1. Salivary amylase activity in relation to substrate concentration
2. Salivary amylase activity in relation to enzyme concentration
3. Chromatographic separation of amino acid
4. Quantitative analysis of protein – Lowry/Biuret method
5. Preparation of standard graph for carbohydrate
6. Preparation of standard graph for Protein

Spotter/Chart

Kreb's cycle, β oxidation, ketogenesis, structure of protein, haemoglobin, amino acid – lysine and alanine

Sericulture Practicals

1. Dissection: Silkworm digestive system, silk gland
2. Morphology of larva pupa and moth, sex separation in pupa and moth

3. Mouth parts of silkworm

4. Identification and study of sericulture products

5. Rearing appliances: rearing tray, leaf chamber

6. Mountage – Chandrike

7. Diseases of Silkworm –bacterial, fungal

8. Types of mulberry leaves (MR2, K2) and diseases of mulberry (fungal and Nematode

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	2	1	3
CO2	3	3	3	2	2	2	3
CO3	3	3	3	1	2	1	3
CO4	3	3	3	2	2	2	3
Total Score	12	12	12	6	8	6	12

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	3	2	3
CO2	3	3	3	2	3	2	3
CO3	3	3	3	3	3	2	3
CO4	3	3	3	3	3	3	3
Total Score	12	12	12	10	12	9	12

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	GENETICS	CORE	5	-	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the principles of genetic transmission, gene structure and function, population genetics, and human genetics, including gene regulation, chromosomal abnormalities, and genetic disorders.
CO2 (K3)	Apply genetic principles and population genetic models to solve problems related to inheritance, gene interactions, mutation, Hardy–Weinberg equilibrium, pedigree analysis, and human genetic traits.
CO3 (K4)	Analyze the molecular basis of gene action, mutation, DNA replication and repair, extra-chromosomal inheritance, population genetic variations, and the genetic basis of human diseases and complex traits.
CO4 (K5 & K6)	Evaluate genetic data and develop scientific interpretations regarding inheritance patterns, genetic disorders, gene therapy and the application of modern genetic techniques in human welfare and disease management.

Unit I

Principles of genetic transmission: Concepts and definitions – Mendelian principles – Allelic and non-allelic interactions – Pleiotropy – Penetrance and expressivity – Phenocopies – Multiple alleles – Polygenic inheritance – Linkage and Crossing over – tetrad analysis – ClB technique – Sex determination – Sex linked inheritance – Nondisjunction.

Unit II

Gene Concept: Fine Structure of gene - Simple and split genes – Intron, Cistron, muton and Recon – Chemical composition of gene - Genes and protein synthesis – Genetic code - works of Khorana and Kornberg – wobble hypothesis - Regulation of gene action – Transposable elements – IS elements – DNA replication – Chemistry of DNA – Gene action related diseases.

Unit III

Mutation and Extra chromosomal inheritance: DNA damage and repairing mechanism – Gene mutation – molecular basis of mutation – mutagens – causes of mutation – Extra chromosomal inheritance – Kappa particles in Paramecium – Shell coiling – Inbreeding, out breeding and hybrid vigour.

Unit IV

Population Genetics: Mendelian population – Gene pool and gene frequency – Hardy Weinberg law, Applications of Hardy-Weinberg law in calculating gene frequencies in a population – Calculation of gene frequencies for sex linked genes – Factors affecting Hardy - Weinberg equilibrium.

Unit V

Human Genetics: Pedigree analysis – Aminocentesis – Inborn errors metabolism – Sickle cell anemia – Karyotype – Twins – Chromosomal abnormalities – Genetic Pregnosis – Genetic Counselling – Gene Therapy – Drugs on Human heredity – simple Mendelian traits in man – genetic analysis of complex traits – Threshold traits – DNA finger printing and dermatoglyphics. Eugenics, Euthenics and Euphenics.

Reference books :

1. Elof Axel Carlson, 1985. Human Genetics. Tata Mc Graw-Hill Publishing Co., New Delhi.
2. Jain, H. K., 1999. Genetics : Principles, concepts and implications, Oxford & Publishing Co., New Delhi.
3. Benjamin Lewin, 1997. Genes VI, Oxford University Press, Oxford.
4. Sandhya Mitra, 1994. Genetics – A blueprint of life. Tata Mc Graw Hill Publishing Co., New Delhi.
5. Strickberger, M. W., 1996. Genetics, 3rd Edn., Prentice Hall of India, New Delhi.
6. Gardner et al., 1991. Principles of Genetics, 8th Edn., John Wiley & sons Inc., New York.
7. Stansfield, W. D., 1991. Schaum's Outline of theory and problems of Genetics, 3rd Edn., Schaum's Outline Series, Mc Graw Hill Inc., New York.
8. Stent, G. S. and Calender, R., 1986. Molecular Genetics : An introductory narrative, 2nd Edn., CBS Publishers & Distributors, New Delhi.
9. Goodenough, U., 1984. Genetics, 3rd Edn., Saunders College Publishing, New York.
10. Miglani, G. S., Fundamentals of Genetics, Narosa Publishing House, New Delhi.
11. Lewis, Genes X – Jones and Bartlett Publishers, Oxford Publication.
12. Michael R. Commings, Genage Learning Pvt. Ltd., New Delhi.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	1	1
CO2	3	3	3	2	2	2	1
CO3	3	2	3	2	2	2	2
CO4	3	2	3	2	2	2	2
Total Score	12	10	12	8	8	7	6

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	3	2	3
CO2	3	2	3	2	3	2	2
CO3	3	2	3	2	3	2	3
CO4	3	2	2	2	3	3	2
Total Score	12	8	11	8	12	9	10

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	DEVELOPMENTAL BIOLOGY	CORE	5	-	-

Pre-requisite:

Students have fundamental knowledge in developmental biology.

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the fundamental concepts of animal development including gametogenesis, cleavage, gastrulation, embryonic development and metamorphosis.
CO2 (K3)	Apply the principles of developmental biology to explain mechanisms of fertilization, endocrine regulation, regeneration, and reproductive technologies
CO3 (K4)	Analyze cellular, molecular, and genetic mechanisms involved in embryonic development, regeneration processes, and hormonal control of post-embryonic development.
CO4 (K5 & K6)	Evaluate developmental and regenerative processes in animals and formulate critical interpretations on experimental embryology, cryopreservation, and ethical issues in reproductive biology

Unit I

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

Unit II

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

Unit III

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

Unit IV

Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in mammalian – Organogenesis- Development of endodermal, mesodermal and ectodermal derivatives. Embryonic Induction and neurulation; Formation and migration of neural crest cells - types of neural crest cells and their patterning - primary and secondary neurulation. Genetic control of segmentation – Gap genes; pair rule genes; Homeotic genes

Unit V

Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Types and Mechanism of regeneration.Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Cryopreservation of gametes/embryos - Ethical issues in cryopreservation

Reading list

1. Balinsky, B. I. 1981. Introduction to Embryology (5th Edition), CBS College Publishers, New York, pp-782.
2. Gilbert. S. F. 2006. Developmental Biology, 8th Edition, INC Publishers, USA, pp-785.
3. Berrill, N.J. 1974. Developmental Biology, Tata Mc-Graw Hill Publications, New Delhi, pp-535.
4. Tyler, M.S. 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA, pp-208.
5. Subramoniam, T. 2011. Molecular Developmental Biology (2nd Edition), Narosa Publishers, India, pp-364.
6. www.easybiologyclass.com › developmental-biology-e

7. www.studocu.com › document › lecture-notes › view

Recommended texts

1. Wilt, F.H. and N.K. Wessel. 1967. Methods in Developmental Biology, Thomas Y Crowell, New York.

2. Slack J.M.W.2012. Essential Developmental Biology (3rd Edition), Wily-Blackwell Publications, USA, pp-496.

3. Mari-Beffa, M. and J. Knight. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	1	1
CO2	3	2	2	2	2	2	1
CO3	3	3	3	2	2	2	2
CO4	3	2	3	3	3	2	2
Total Score	12	10	11	9	9	7	6

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	2	2	1	1	1
CO2	3	2	2	2	2	2	1
CO3	2	3	3	3	2	2	2
CO4	2	3	3	3	3	3	2
Total Score	10	10	10	10	8	8	6

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	LAB COURSE IN GENETICS & DEVELOPMENTAL BIOLOGY	CORE	-	4	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the principles of Mendelian inheritance, population genetics, chromosomal abnormalities, sex-linked inheritance, embryogenesis, metamorphosis, larval forms and reproductive cycles in animals.
CO2 (K3)	Apply genetic and developmental biology techniques to perform breeding experiments, estimation of gene and genotype frequencies, identification of genetic traits and observation of embryonic and developmental stages.
CO3 (K4)	Analyze inheritance patterns, genetic drift, chromosomal disorders, operon regulation, larval adaptations, placental variations, and reproductive cycles using practical observations and genetic data.
CO4 (K5 & K6)	Evaluate genetic and developmental biology data and develop scientific interpretations regarding heredity, population genetics, chromosomal abnormalities, embryonic development and metamorphosis in animals.

Genetics

1. Breeding experiments to be demonstrated with the help of colour beads – Monohybrid cross. (using Chi-square test).
2. Breeding experiments to be demonstrated with the help of colour beads – Dihybrid cross. (using chisquare test).
3. Estimation of gene and genotype frequencies in the light of Hardy – Weinberg law based on ABO blood groups.
4. Demonstration of random genetic drift using beads
5. Observation of various genetic traits in human
6. Culture of Drosophila – Demonstration
7. Preparation of buccal smear to show Barr bodies in squamous epithelial cells.

Charts/Slides/Models

1. Down’s syndrome, Klinefelter’s syndrome

2. Turner's syndrome, Edward syndrome

3. Drosophila mutants – White eye and vestigial wings

4. Human Pedigree Chart

5. Lac operon

6. Sex-linked inheritance: X – Linked inheritance, Y- linked inheritance

7. Lytic and lysogenic cycles

8. Blood groups and Rh factor.

Developmental Biology

1. Spermatogenesis Oogenesis (vertebrate) – chart

2. Study of different types of eggs – Amphibia, frog, chick, man – models / chart

3. Frog early development– two celled stage, four celled stage, blastula, gastrula with yolk plug stage – slide / model

4. Observation of insect metamorphosis

5. Larval forms of Invertebrata- redia, cercaria, zoea, mysis, veliger, bipinnaria

6. Temporary mounting of chick blastoderm

7. Observations of whole mounts of chick embryos – 24, 48, 72 & 96 h - slides / chart

8. Observation different types of placenta : Diffuse placenta, Cotyledonary placenta, zonary placenta, monodiscoidal placenta and bidiscoidal placenta.

9. Slides showing the uterine cycles in a mammal.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	2	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	2	2
CO4	3	3	3	2	3	2	2
Total Score	12	12	12	8	9	8	8

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	2	2	2
CO2	3	3	3	3	2	2	2

CO3	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**3**	**2**
Total Score	**12**	**12**	**12**	**12**	**8**	**9**	**8**

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	BIOSTATISTICS	ELECTIVE	4	-	-

Pre-requisite:

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

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the basic concepts, scope, applications, and methods of statistics including data collection, graphical representation, measures of central tendency, probability and analysis of variance
CO2 (K3)	Apply the acquired skills to perform various statistical analyses using modern statistical techniques and software.
CO3 (K4)	Analyze biological data using statistical tools such as correlation, regression, probability distributions, t-tests, and analysis of variance to interpret relationships and variations in datasets.
CO4 (K5 & K6)	Evaluate statistical outcomes and develop appropriate interpretations and predictions from biological data using advanced statistical methods and comprehensive data analysis through SPSS.

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

Unit I

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

Unit II

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

error, and coefficient of variation.

Unit III

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

Unit IV

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

Unit V

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

Reading list

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

Recommended texts

1. Bailey, N. T. J. 1959. Statistical in Biology, English Universities Press, London, pp-48.
2. Sokal, R. R. and F. J. Rohlf, 1973. Introduction to Biostatistics, W.H. Freeman, London, pp-467.
3. Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco: W.H. Freeman, London, pp-859.
4. Zar, J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore) Pvt. Ltd., Delhi, India, pp-660.
5. Bailey, N. T. J. 1994. Statistical Methods in Biology (Third Edition), Cambridge University Press, Cambridge, pp-255.
6. Wayne W. Daniel. Biostatistics: A Foundation for Analysis in the Health Sciences, John

Wiley & Sons Inc, USA, pp-443.

7. Snedecor, G. W. and W. G. Cochran. 1967. Statistical Methods (Sixth Edition), Oxford & IBH Publishing Co., New Delhi, pp-593.
8. Pagano, M. and K. Gauvreau. 2008. Principles of Biostatistics (Second Edition), Cengage Learning, New Delhi, pp-525.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	2	2
CO2	3	3	3	3	2	2	2
CO3	3	3	3	3	2	2	1
CO4	3	3	3	3	2	2	1
Total Score	12	12	12	12	9	8	6

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	3	2	2
CO2	3	3	3	2	2	2	2
CO3	2	3	3	2	2	2	2
CO4	2	3	3	2	3	2	2
Total Score	10	12	12	8	9	8	8

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	RESEARCH METHODOLOGY	ELECTIVE	4	-	-

Pre-requisite:

Students should know the fundamentals of basic methods employed in experimental biology.

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the principles, components, and applications of microscopy, histological techniques, spectroscopy, chromatography, research frameworks, and scientific publication processes
CO2 (K3)	Apply the laboratory instruments and analytical techniques such as staining, centrifugation, electrophoresis, PCR, and spectroscopic methods for biological research and data analysis.
CO3 (K4)	Analyze the experimental data, molecular separation techniques, and scientific literature to interpret biological observations and research findings.
CO4 (K5 & K6)	Evaluate the research outcomes and develop scientific reports, thesis, and research publications using appropriate analytical tools, journal selection criteria, citation metrics and plagiarism detection methods

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

Unit I

Microscopy: Compound (Dark and Light field), Phase Contrast, Fluorescent, Polarized, Electron (Transmission and Scanning), AFM and Confocal Microscope - Micrometry.

Unit II

Histology- Sectioning, fixation and staining of tissues. Centrifuge Clinical, Density gradient and Ultra - sedimentation coefficient. GM counter, Liquid Scintillation counter, Lyophilizer, Spectrophotometer (visible, U ltraviolet), ELISA Reader. FTIR, NMR, XRD, Atomic Absorption and Mass Spectrophotometer.

Unit III

Chromatography: Paper, Thin layer, Column, gel filtration, ion exchange, Gas and HPLC, PAGE, Agarose Gel Electrophoresis, 2D Gel Electrophoresis, Western blotting, and PCR – DNA Sequencing Methods.

Unit IV

Identification of research problems - Steps in formulating a research problem. Thesis writing - Introduction, Review of literature, Methodology, Results - illustrations and tables, Discussion, Bibliography – Citation Management Tools.

Unit V

Publication of research and review articles – choosing the right journal; refereed journals, open access journals, Journal metrics, citation, impact factor, SCI, H index, i10 index, software for paper formatting MS Office, Software for detection of Plagiarism – AI Tools in research Writing.

Reading list

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

Recommended texts

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

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	3	3	2	3
CO2	3	3	3	3	3	2	2
CO3	3	3	3	2	3	2	2
CO4	3	3	3	3	3	2	2
Total Score	12	12	12	11	12	8	9

Level of Correlation: 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	3	3	3	2	2
CO2	2	3	3	3	2	2	1
CO3	2	3	3	2	2	2	2
CO4	2	3	3	2	3	3	2
Total Score	8	12	12	10	10	9	7

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	ENTOMOLOGY	SKILL ENHANCEMENT COURSE	4	-	-

Pre-requisite:

The students with a basic background in biological sciences with a special emphasis on the study of insects including systematic, beneficial insects, destructive insects, integrated pest management and insects of medical and veterinary importance.

Course Outcomes (COs)

Upon completion of this course, students could

CO	Course Outcome Statement	K Level
CO1	Understand the insect classification, biology, beneficial insects, pest insects and vector biology.	K1 & K2
CO2	Apply techniques for insect collection, preservation, pest identification and insect management practices.	K3
CO3	Analyze insect behavior, pest outbreaks, biological control methods and vector-borne disease transmission.	K4
CO4	Evaluate pest management strategies, economic importance of insects and modern applications of entomology in agriculture, medicine and forensic science.	K5 & K6

Unit I

Scope and history of Entomology - Branches of Entomology - Principle of insect classification. Classification of insects up to order - key Characteristics with Indian examples. Insects and their biological success. Collection and preservation of insects.

Unit II

Beneficial insects: Silkworms - types, life history, disease management and rearing methods - Types of honeybees, life history, social organization (colonies and caste system), honeybee care and management of beehive - Lac insects-life history, lac cultivation; Pollinators, predators, parasitoids, scavengers, weed killers, soil builders.

Unit III

Destructive insects: Insect pests - definition - Categories of pests - Types of damage to plants by insects - Causes of pest outbreak - Economic threshold level - Biology of the insect pests - Pests of paddy, cotton, sugarcane, brinjal vegetables, coconut, stored grains and cereals.

Unit IV

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

Unit V

Vector biology **and Medical Entomology**: Vectors of veterinary and public health importance – **Vector Borne diseases and its control measures**. Man and insects: The value of insects – insects as protein sources of human and animal feeds. Medicinal use of insects. Forensic Entomology. **Insects as bioindicators**

Reading list

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

Recommended texts

1. Chapman, R.F., S.J. Simpsonand A.E.Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959.
2. Imms, A.D., O.W.Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands.
3. Daly, H.V., J.T. Doyen and P.R. Ehrlich. 1978. Introduction to Insect Biology and Diversity. Mc Graw-Hill Kogakusha Ltd., Tokyo, pp-564.

4. Hill, D.S. 1974. Agricultural Insect Pests of the Tropics and Their Control. Cambridge University Press, New York, pp-746.
5. Krishnaswami, S. 1973. Sericulture Manual, Vol. I & II, Silkworm rearing, FAO Agricultural Science Bulletin, Rome.
6. Mani, M.S. 1982. General Entomology. Oxoford & IBH Publishing Co., pp-912.
7. Wigglesworth, V.B. 1972. The Principles of Insect Physiology, ELBS & Chapman and Hall, London, pp-827.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	2	2	2
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	3	2	3
Total Score	10	11	9	8	8	8	8

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	2	1	2	1
CO2	3	2	2	3	2	2	2
CO3	2	3	3	3	2	2	2
CO4	2	3	3	3	3	3	3
Total Score	10	9	9	11	8	9	8

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	LAB COURSE IN BIOSTATISTICS & RESEARCH METHODOLOGY	ELECTIVE	-	4	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the principles of biostatistical analysis, hypothesis testing, laboratory instrumentation, buffer preparation, pH measurement, microscopy and electrophoretic techniques
CO2 (K3)	Apply statistical methods to calculate measures of central tendency, correlation, regression, probability, and significance tests, and perform laboratory procedures using pH meters, microtomes, and chromatographic techniques.
CO3 (K4)	Analyze biological data using statistical tools and interpret experimental results obtained from microscopy, colorimetry, chromatography, and other research methodologies.
CO4 (K5 & K6)	Evaluate statistical and experimental findings and develop scientific interpretations for biological research using appropriate analytical, quantitative, and laboratory techniques.

Biostatistics Practical

1. Calculation of mean, median, mode, standard deviation, standard error, variance and coefficient of variation - individual observation.
2. Calculation of mean, median, mode, standard deviation, standard error, variance and coefficient of variation – continuous series.
3. Calculation of correlation coefficient – length and width of leaves.
4. Calculation of regression co-efficient using length and width of leaves.
5. Probability experiment with coin tossing (one coin, two coins). using chi square test
6. Test of significance for small samples – student's t test.

Research Methodology Practical

1. Preparation of buffers and determination of pH using pH Meter
2. Centrifuge – techniques, types.
3. Phase contrast microscope – principle
4. Micrometry – measurement of cells.
5. Colorimeter – Verification of Beer Lambert's law
6. Microtome techniques – staining procedure
7. Electrophoresis (demonstration only)
8. Separation of amino acids and sugars using paper chromatography
9. Spotters: Spectrophotometry, Flame Emission Photometry, thin layer, column and gas chromatography

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	2	1	2
CO2	3	3	3	2	2	2	2
CO3	3	3	3	2	2	1	2
CO4	3	3	3	2	2	2	2
Total Score	12	10	12	8	8	6	8

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	2	2	3
CO2	3	3	3	3	2	2	3
CO3	2	3	3	2	3	2	3
CO4	2	3	3	2	3	3	2
Total Score	10	12	12	10	10	9	11

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	CELL AND MOLECULAR BIOLOGY	CORE	6	-	-

Pre-requisite:

Students should have knowledge of the basic cellular structures and their salient functions in prokaryotic and eukaryotic cells.

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the structure, organization and general concepts of cell, cell organelles, membrane organization, cell signalling, and cancer cell characteristics.
CO2 (K3)	Apply the concepts of membrane transport, intracellular organization, cell cycle regulation, and signalling pathways to interpret cellular processes and functions.
CO3 (K4)	Analyze the mechanisms of cell communication, importance of physical and chemical signals at the molecular level.
CO4 (K5 & K6)	Evaluate the significance of molecular mechanisms in maintaining normal cell function and formulate critical interpretations for cancer control.

Unit I

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

Unit II

Cellular organization: Membrane structure and functions – Transport Mechanism - ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes. Structure and functions of Intracellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles and chloroplasts.

Unit III

Cell division and Cell cycle: Mitosis and meiosis, their regulation, steps in cell cycle and control of cell cycle. Molecular biology of cell: Structure of DNA and RNA; Process of DNA replication, transcription, and translation in pro- and eukaryotic cells; DNA Repair and Regulation of Gene Expression.

Unit IV

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

Unit V

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

Reading list

1. Plopper, G., D. Sharp, and E. Sikorski. 2015. Lewin's Cells (Third Edition), Jones & Bartlett, New Delhi, pp-1056
2. Plopper, G. 2013. Principles of Cell Biology, Jones & Bartlett, Maryland, pp-510

Recommended texts

1. Karp, G. 2010. Cell Biology (Sixth Edition), John Wiley & Sons, Singapore, pp-765.
2. Lodish, H., C. A. Kaiser, A. Bretscher, et al., 2013. Molecular Cell Biology (Seventh Edition), Macmillan, England, pp-1154
3. De Robertis, E.D.P. and E. M. F. De Robertis Jr, 1987. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734
4. Abbas, A. K., A. H. Lichtman and S. Pillai, 2007, Cell and Molecular Immunology (Sixth Edition), Saunders, Philadelphia, pp-566
5. Loewy, A.G., P. Siekevitz and J. R. Menninger, et al., 1991, Cell Structure and Function (Third Edition), Saunders, Philadelphia, pp-947
6. Watson, J. D., N.H. Hopkins, J.W. Roberts, et al., 1987, Molecular Biology of the Gene (Fourth Edition), Benjamin/Cummings, California, pp-1163
7. Han, S. S. and J. Holmstedt. 1979, Cell Biology, McGraw Hill, pp-319
8. Alberts, B., A. Johnson, J. Lewis, et al., 2015, Molecular Biology of the Cell (Sixth

Edition), Garland Science, New York, pp-1342

9. Clark, D.P., 2005. Molecular Biology, Elsevier, China, pp-784
10. Tropp, B. 2008. Molecular Biology Genes to Proteins (Third Edition), Jones & Bartlett, US, pp-1000

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	1	2	1	1
CO2	3	3	2	1	2	2	1
CO3	3	3	3	2	2	1	2
CO4	2	3	3	3	2	2	2
Total Score	11	11	10	7	8	6	6

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	2	1	2	1
CO2	3	2	2	2	2	2	1
CO3	2	3	3	3	2	2	2
CO4	2	3	3	3	3	3	2
Total Score	10	9	9	10	8	9	6

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	ANIMAL PHYSIOLOGY	CORE	6	-	-

Pre-requisite:

Students should know the fundamentals of structure and functions of organs and organ systems of animals.

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the structure and functions of different systems of animals, including the physiological mechanisms involved in maintaining homeostasis in humans.
CO2 (K3)	Apply physiological principles to explain body metabolism, nerve impulse transmission, muscle contraction, endocrine regulation, reproduction, thermoregulation, and adaptation to environmental changes.
CO3 (K4)	Analyze the functional relationships among organ systems and interpret physiological processes such as blood circulation, gas exchange, renal function, neural control, hormonal regulation, and stress responses in maintaining body functions.
CO4 (K5 & K6)	Evaluate physiological mechanisms underlying health and disease and develop scientific interpretations of homeostatic regulation, endocrine disorders, reproductive physiology, thermoregulation, and adaptive responses in humans.

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

Unit I

Digestive system: - Human Digestive Tract & Functions – Digestion – Role of Enzymes in Digestion of Carbohydrates, Protein, Lipids, Absorption – Gastrointestinal Hormone, Intestinal villi. Balanced Diet, Mal Nutrition and BMR. Digestion, absorption, energy balance, BMR.

Unit II

Blood and circulation: Blood corpuscles, hemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, co-agglutination, haemostasis. Cardiovascular system: Anatomy of human heart, myogenic heart, Arteries and Veins, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of heart.

Unit III

Respiratory system: Structure & Function of human lung and the respiratory tract. Respiratory Pigments, transport of gases, exchange of gases, neural and chemical regulation of respiration. Excretory system: Structure of the kidney – Nephron Renal Circulation - Urine formation, Renal disorders – Micturition and Dialysis. Regulation of water and electrolytes Balance, Acid Base Balance.

Unit IV

Nervous system: Neurons, action potential, gross neuro-anatomy of the brain and spinal cord, central and peripheral nervous system, Muscles – classification, Ultra Structure of skeletal muscles. Mechanism of Muscular contraction. Neural control of muscle tone and function. Sense organs: Vision, hearing and tactile response.

Unit V

Endocrinology and reproduction: Structure & Function of Endocrine glands, Basic mechanism of hormone action, Hormones & diseases, Neuro Endocrine regulation of reproduction. Thermoregulation: Comfort zone, body temperature- physical, chemical, neural regulation, acclimatization: Stress and adaptation.

Reading list

1. Prosser C. L. 1991, Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley-Liss Publishers, pp-592

2. Hoar, S.W. 1983, General and Comparative Physiology,Prentice Hall Publication, pp-928.

3. Randall, D., W. Burggren, K. Frenchand R. Eckert.2001, Animal Physiology Mechanisms and Adaptations, New York: W.H. Freeman and Co., pp-

4. Nelson K. S. 1997. Animal Physiology: Adaptation and Environment, Cambridge University Press, pp- 617.

5. https://swayam.gov.in/nd1_noc20_bt42/preview

6. https://www.classcentral.com/course/swayam-animal-physiology-12894

7. https://swayam.gov.in/nd1_noc20_hs33/preview

8. General and Comparative Physiology – William S. Hoar.

Recommended texts

1. Shepherd, G. M. 1994.Neurobiology, OUP USA Publisher, pp-774.

2. Hainsworth, F.R. 1981. Animal Physiology: Adaptation in function, Addison Wesley Longman Publishers, pp-669.

3. Gorden, M.S. *et al.,* 1977. Animal Physiology: Principles and Adaptation, New York, Third Edition.

4. Ahearn, G.A. *et al.,* 1988. Advances in Comparative and Environmental Physiology – 2, Springer Publishers, pp-252.

5. Hill, R.W. 1976. Comparative Physiology of Animals: Environmental Approach, Longman Higher Education Publisher, pp-656.

6. Textbook of Animal Physiology – R.Nagabhushanam, M.S Kodarkar and R.Sarojini.

7. Gayton, A.C. and Hall, J.E., A Textbook of Medical Physiology, 9thEdn., Harcourt Brace

and Company Asia Pvt. Ltd., W.B. Saunders Company.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	3
CO2	3	2	3	2	2	2	3
CO3	3	3	2	2	2	2	3
CO4	3	3	3	2	3	2	2
Total Score	12	10	10	8	9	8	11

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	3	2	3	2	3
CO2	3	2	3	2	3	2	2
CO3	2	3	3	3	2	2	2
CO4	2	3	3	2	3	3	1
Total Score	10	10	12	9	11	9	8

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	LAB COURSE IN CELL & MOLECULAR BIOLOGY AND ANIMAL PHYSIOLOGY	CORE	-	4	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the principles and procedures involved in cytological, molecular biological, and physiological techniques including electrophoresis, enzyme activity, osmoregulation, and physiological instrumentation.
CO2 (K3)	Apply the knowledge on laboratory experiments related to cell and molecular biology such as micrometry, mitosis and meiosis studies, SDS-PAGE, blood smear preparation, enzyme assays, and physiological investigations in animals
CO3 (K4)	Analyze cellular structures, chromosomal features, excretory products, and hematological characteristics using experimental observations and laboratory data.
CO4 (K5 & K6)	Evaluate experimental results and develop scientific interpretations regarding cell division, molecular separation techniques, physiological adaptations, and organ system functions in animals.

Cell and Molecular Biology

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

9. Agarose gel electrophoresis of DNA

10. SDS-Polyacrylamide gel electrophoresis

Animal Physiology

1. Detection of haemin crystals in blood

2. Rate of salt loss and salt gain in fish

3. Effect of temperature on opercular activity of fish

4. Qualitative analysis of excretory product in ammonotelic, ureotelic, and uricotelic animals.

5. Determination of the salivary amylase activity in relation to temperature.

6. Preparation of human blood smear

7. Separation of uric acid crystals from excreta of reptiles / birds.

Charts/Slides/Models/Instrument

1. EEG, ECG, Cardiac muscle, Kymograph, Sphygmomanometer, Pituitary, thyroid, testis and ovary, adrenal, kidney, microvilli

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	3	2	3
CO2	3	3	3	2	3	2	3
CO3	3	3	3	2	3	2	3
CO4	3	3	3	2	3	2	2
Total Score	12	12	12	8	12	8	11

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	3	3	2	3
CO2	3	3	3	3	3	2	3
CO3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3

Total Score	**12**	**12**	**12**	**12**	**11**	**9**	**12**

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	EVOLUTION	ELECTIVE	-	4	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the origin of life, evidences of evolution, theories of organic evolution, mechanisms of evolutionary change, origin of higher taxa, and the evolutionary history of humankind.
CO2 (K3)	Apply evolutionary principles, population genetics concepts, geological evidence, and speciation mechanisms to interpret patterns of biological diversity and evolutionary relationships among organisms.
CO3 (K4)	Analyze evolutionary processes including natural selection, genetic drift, migration, isolation, adaptive radiation, extinction, evolutionary rates, and the phylogenetic relationships among major taxa and human ancestors.
CO4 (K5 & K6)	Evaluate evolutionary theories and evidence, and develop scientific interpretations of the origin, diversification, adaptation, and evolutionary trends of organisms, including the biological and cultural evolution of humans.

Unit I

Origin of cells and unicellular evolution : Origin of basic biological molecules, abiogenesis, biogenesis, Biochemical origin of life, biological evolution (protenoids and microsphere coacervates), biogeny of protein and nucleic acid , concept of Oparin and Haldane – Experiment of Urey and Miller

Unit II

Evidences and Theories of Evolution : Evidences : From Paleontology – Geological time scales and its major events - Types of fossils and process of fossilization – Evidences from biogeography – Evidences from morphology, comparative anatomy, embryology, biochemistry and physiology. Theories of organic evolution : Lamarkism, Darwinism, Mutation theory, Modern synthetic theory.

Unit III

Mechanism of Evolution : Population genetics – population, gene pool, gene frequency ; Hardy – Weinberg law, Gene frequency and its impacts, natural selection, migration and genetic drift, variations, isolating mechansism and origin of species – Allopatric and sympatric speciation.

Unit IV

Origin of Higher Taxa : Simpson's definition of the higher taxa, Simpson's adaptive grid, pre-adaptations and post-adaptations, patterns of evolution : convergent evolution and parallel evolution, Micro evolution, Macro evolution (adaptive radiation), Mega evolution, Connecting link between vertebrate classes, quantum evolution. Rates of Evolution : Horotely, Bradytely and Tachytely, Graduation versus punctuated equilibrium, Extinction and its causes.

Unit V

Mankind evolution : Phylogenetic tree and stages of primate evolution including Homo sapiens. Place and time of origin, characteristics and ancestors of man. Evolutionary trends of man evolution, cultural evolution of man, allometry, altruism and kith and kin selection.

Reference Books

1. Moody, P. A., 1978. Introduction to evolution (Harper International).
2. Stebbins, C. L., 1979. Processes of organic evolution (Prentice – Hall India, New Delhi).
3. Dodson, E. O., 1980. Evolution, Reinhold, New York.
4. Veer Bala Rastogi, Evolutionary Biology.
5. Sanjib Chattopadhyay – Origin, Evolution and Adaptation, Books and Allied (P). Ltd., 8/1, Chintamoni Das Lane, Kolkata, India.
6. Ayala, F. J., 1978. Molecular Evolution, Sinaller, Mass, USA
7. Sondalled, D. S., 1983. Evolution from molecules to man, Cambridge University Press.
8. Dobzhansky, Th., 1970. Genetics of the evolutionary process, Columbia University Press, New York.
9. Dobzhansky and Ayala, 1977. Evolution, W. H. Freeman, San Francisco.
10. Ernst Mayr, 1976. Evolution and the diversity of life, Hardward University Press.
11. Minkoff, E. C., 1984. Evolutionary Biology, Wesley, London.

12. Simpson, G. G., 1953. The major features of evolution, Columbia University Press, New York.

13. Simpson, G. G., 1969.Meaning of Evolution, Oxford IBH, New Delhi.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	3
CO2	3	2	2	2	2	2	2
CO3	2	2	3	2	2	2	2
CO4	2	3	3	2	2	2	2
Total Score	10	9	10	8	8	8	9

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	2	3	2	3	2	3
CO2	3	2	3	2	3	2	2
CO3	2	2	2	3	2	2	2
CO4	2	2	2	3	2	2	2
Total Score	10	8	10	10	10	8	9

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	APPLIED BIOTECHNOLOGY	ELECTIVE	-	4	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the fundamental concepts of biotechnology, genetic engineering tools, recombinant DNA technology, gene therapy, and nanobiotechnology along with their applications in human welfare and environmental management.
CO2 (K3)	Apply molecular and biotechnological techniques such as PCR, DNA fingerprinting, blotting, tissue culture and nanotechnology-based approaches in biological research and industrial applications.
CO3 (K4)	Analyze the role of genetic engineering, transgenic organisms, bioprocesses, stem cell technology, gene therapy, and nanobiotechnology in medicine, agriculture, industry, and environmental sustainability.
CO4 (K5 & K6)	Evaluate modern biotechnological innovations and develop scientific solutions utilizing r DNA technology, transgenic organisms and nanobiotechnology for healthcare, environmental remediation, renewable energy, and sustainable development.

Unit I

Introduction to Biotechnology: Tools of Genetic Engineering - Vectors - Cloning and Expression Vectors - Plasmids, Bacteriophage, Cosmids, Shuttle Vectors, Yeast Vectors. Enzymes - Restriction Endonucleases, Ligases, Reverse Transcriptases, Polymerases, Terminal Transferases and Isozymes. Nucleic acid Probes and Molecular markers - RFLP, RAPD.

Unit II

Techniques in Genetic Engineering - selection and isolation of desired genes, gene splicing, introduction of rDNA into host, selection of clone containing DNA insert, PCR,

DNA finger printing, blotting techniques, DNA sequencing, genomic library, cDNA library.

Unit III

Biotechnology and Human Welfare: Tissue Plasminogen Activator, Erythropoitein, Interferons, Recombinant Vaccines, Monoclonal Antibodies Production. Genetically modified organisms (GEMO's) - Transgenic Mice and Cattle - Gene Pharming. Bioterrorism. Bioprocess Technology: Overview of Upstream & Downstream processing. Production of industrially important antibiotics, Single Cell Production. Role of GMOs in Biodegradation. Biotechnological Applications in Environmental Management, Biodiesel production and Bioplastics.

Unit IV

Animal Biotechnology: Artificial Insemination in Cattle, Embryo Transfer, Cryopreservation, Stem Cell Therapy, Targeted Gene Transfer - Gene knockouts. Cell culture : Organ culture, whole embryo culture, embryo transfer - in-vitro fertilization (IVF) technology. Dolly- in vitro fertilization and embryo transfer in human. Transgenic animals. Human gene therapy. Cryobiology.

Unit V

Introduction to Nanobiotechnology: History and Scope of Nanotechnology. Nano materials - definition, types and properties. Development of nanomedicines - nanotechnology in diagnostic applications. Application of Nanobiotechnology: Application in green energy, environmental remediation - pollution in industrial and waste water treatment. Application of Nanotechnology in the treatment of infectious diseases, nanomaterials in cancer diagnosis and therapy.

Reference books:

1. Satyanarayana, U.2007. Biotechnology. Uppala author-publisher interlinks,Vijayawada, Andhra Pradesh, India.
2. Old,R.W and Primrose, S.B.1993.Principles of Gene manipulation: An introdution to Genetic Engineering.Blackwell Science Publication.
3. Ignacimuthu, S.2008. Biotechnology: An introduction, Narosa Publishing house, New Delhi.

4. Purohit, S.S.2008. Biotechnology. Student Edition, Jodhpur. Lee and Savage, L.M. Biological
5. Molecules in Nanotechnology. Biological Molecules in Nanotechnology – By Ratner M and Ratner D – Nerosha Publishing house, New Delhi.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	3	2	3	2	3
CO2	3	3	3	2	3	2	3
CO3	3	3	3	2	3	2	2
CO4	2	3	3	3	3	2	2
Total Score	11	11	12	9	12	8	10

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	3	2	3	3	2
CO2	3	2	3	3	3	3	2
CO3	2	2	3	3	3	3	3
CO4	2	2	3	3	3	3	3
Total Score	10	8	12	11	12	12	10

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	APICULTURE	SKILL ENHANCEMENT COURSE	4	-	-

Pre-requisite:

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

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the history, classification, life cycle, behaviour, social organization of honey bees, hive types, bee products, diseases, and the scope of apiculture.
CO2 (K3)	Apply bee-keeping techniques, hive management practices, disease control measures and processing methods for the production and marketing of bee products
CO3 (K4)	Analyze the behavioural patterns of honey bees, factors affecting apiculture, causes of colony collapse disorder, bee enemies and the economic importance of bee products and apiculture industries.
CO4 (K5 & K6)	Evaluate apiculture practices and develop sustainable bee management and entrepreneurial strategies for effective honey bee cultivation, disease management, and commercial production of bee products.

Unit I

Introduction to Apiculture. History, classification, types, life Cycle of different species of Honey Bees and their behavioural patterns. Social organization of bee colony

Unit II

Bee-keeping system, tools and equipment's needed for bee keeping. Types of bee hives, structure and functional features. Criteria for site selection for apiculture and factors affecting them.

Unit III

Identification and characteristics and Preventive measures to be taken against of different bee enemies. Diseases affecting honey bees and their control measures. Colony collapse disorder and its management.

Unit IV

Bee products, uses and importance- Honey, Royal jelly, Propolis, Pollen and Bee venom. Harvesting, Processing, Packaging and Marketing of bee products.

Unit V

Apiculture industry around the world and Role of Central Bee Research & Training institute in India. Apiculture as an Entrepreneurial venture.

Reading list

1. Singh, D., Singh, D. Pratap. 2006. A Handbook of Beekeeping. AGROBIOS (INDIA)
2. Sharma P.L. and Singh, S.H. Book of Bee keeping.
3. Cherian and Ramanathan, S. Bee keeping in south India.
4. Prospective in Indian Apiculture - R.C. Mishra.

Recommended texts

1. Caron, D.W. 2013 (revised from 1999). Honey Bee Biology and Beekeeping. Wicwas Press. Cheshire, CT, 368 pp.
2. Kaspar, R., C. Cook, and M. D. Breed. 2018. Animal Behaviour 142: 69-76.
3. Hendriksma, H. P., A. L. Toth, and S. Shafir. 2019. Individual and Colony Level Foraging decisions of Bumble Bees and Honey Bees in Relation to Balancing of Nutrient Needs. Frontiers in Ecology and Evolution 7: 177.
4. Steinhauer, N. et al. 2018. Drivers of Colony Loss. Current Opinion in Insect Science 26: 142- 148.
5. Technology and value addition of Honey - Dr. D. M. Wakhle and K. D. Kamble.
6. ABC & XYZ of Bee culture - A. I. Root.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	2	2	2	2	3
CO2	3	2	3	2	2	2	3
CO3	2	3	3	2	2	2	3
CO4	2	3	3	2	3	2	2
Total Score	10	10	11	8	9	8	11

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	3	2	3	2	3
CO2	3	2	3	2	3	2	3
CO3	2	3	3	3	2	2	3
CO4	2	3	3	3	3	3	3
Total Score	9	10	12	10	11	9	12

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	LAB COURSE IN EVOLUTION & APPLIED BIOTECHNOLOGY	ELECTIVE	-	2	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the fundamental concepts of evolution, natural selection, genetic drift, Hardy–Weinberg equilibrium, adaptive radiation, fossils along with basic biotechnological techniques, products, tools, and applications.
CO2 (K3)	Apply practical exercises related to evolutionary studies, estimation of gene and genotype frequencies, and biotechnological procedures and demonstrations of fermentation and molecular biology techniques.
CO3 (K4)	Analyze evolutionary mechanisms, fossil evidence, adaptive traits, genetic variation, and the principles underlying diagnostic and molecular biotechnology techniques including ELISA, blotting methods, and bioprocess technology.
CO4 (K5 & K6)	Evaluate experimental observations and develop scientific interpretations regarding evolutionary processes and biotechnological applications in healthcare, agriculture, environmental management, and industrial production.

Evolution Practicals

1. Demonstration of natural selection with colour beads.
2. Study on Evolutionary significances of any five fossils.
3. Study of analogy (wings of animals) and homology (Forelimbs and hindlimbs of vertebrates).
4. Estimation of gene and genotype frequencies in the light of Hardy-Weinberg Law based on

facial traits.

5. Adaptive radiation – beaks of various birds.
6. Demonstration of genetic drift with colour beads.

Charts / Models / Slides

 Geographical isolation

 Phylogram, Mimicry and colouration of animals

 Connecting Links – Archaeopteryx, Limulus, Peripatus

Applied Biotechnology Practicals

1. Estimation of citric acid in citrus fruits
2. Preparation of wine - Demonstration
3. Preparation of bread - Demonstration
4. Preparation of yoghurt - Demonstration
5. Diagnosis of diseases using ELISA - Demonstration
6. Preparation of Vermicompost - Demonstration
7. Extraction of genomic DNA from bacteria - Demonstration
8. Southern and Northern blotting techniques –charts
9. Flow Charts - Bioreactor - Antibiotics production
10. Spotters

 pBR322

 Lambda phage

 Dolly

 RAPD

 Gene cloning

Stem cells

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	2	3	2	3
CO2	3	3	3	2	3	2	3
CO3	3	3	3	2	3	2	3
CO4	3	3	3	2	3	2	2
Total Score	12	12	12	8	12	8	11

Level of Correlation : 3 – High ; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7

CO1	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO3	**2**	**3**	**3**	**2**	**3**	**2**	**2**
CO4	**2**	**3**	**3**	**2**	**3**	**3**	**2**
Total Score	**10**	**12**	**12**	**10**	**12**	**9**	**10**

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	IMMUNOLOGY	CORE	5	-	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the fundamental concepts of immunity, immune organs, immune cells, antigens, antibodies and immune responses.
CO2 (K3)	Apply immunological principles to understand antigen-antibody interactions, vaccine development, complement activation and immune mechanisms.
CO3 (K4)	Analyze cellular and humoral immune responses, antigen presentation, cytokine functions and immune regulation.
CO4 (K5 & K6)	Evaluate immunological disorders, host-pathogen interactions, transplantation and tumor immunity for disease management and therapeutic applications.

Unit I

Introduction to Immunology: An overview; Historical perspective, Concepts of external and internal defense systems; External (first line / innate) defense system: components, distribution; Internal (second line / acquired) immune system: cellular and humoral immune components- distribution, salient functions-primary and secondary immune responses; Immune tissues / organs: types, anatomical location, structure and development; lymphocyte traffic during development; Types of immunity: innate and acquired - types, functional features.

Unit II

Antigens: Definition, characteristic features and classification; Antigenicity versus immunogenicity; Adjuvants: definition, types and applications. Vaccines: Types, Preparations, efficacies and recent developments: Complement System Components, three major activation pathways and immune functions including

Graphylaxis and inflammation.

Unit III

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

Unit IV

Major effector components of humoral immune system: Antibodies - Primary structure, classification, variants and antigen-antibody interactions; Structural and functional characteristics of various antibody classes; Generation of diversity; Monoclonal antibodies: Hybridoma Technology. Cytokines -Definition and salient functional features; Interleukins: definition, types (lymphokines and monokines), and functions. Interferons - Origin, types and functions

Unit V

Diseases and immune responses: Hypersensitivity: definition, Types I to IV and immune manifestations; Auto-immune diseases: onset, spectrum of diseases, and major immune responses; Immunodeficiency diseases: types including SCID and consequences; Viral (HIV), bacterial (tuberculosis) and parasitic (malaria) diseases: etiology, host immune responses and evasion by pathogens; Tumour immunology, transplantation immunology.

Reading list

1. Kuby, J. 1997. Immunology. W. H. Freeman & Co., New York, pp-670.
2. Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7th edition), Mosby / Elsevier, Philadelphia, pp-472
3. Abbas, A. K and A. H. Lichtman. 2007. Cellular and Molecular Immunology (6th edition), W. B. Saunders, Philadelphia, pp-564
4. Coica, R. Sunshine, G. 2015. Immunology (Seventh Edition), Wiley Blackwell, UK, pp-406.

Recommended texts

1. Weir, D. M and J. Stewart. 1997. Immunology, Churchill Livingstone, London, pp-362
2. Janeway, C. A and P. Travers. 1997. Immunology, Garland Publ. Inc., London, pp-904
3. Peakman, M and D. Vergani. 1997. Basic and Clinical Immunology, Churchill Livingstone, London, pp 366
4. Parham, P. 2009. The Immune System (Third Edition), Garland Science, USA, pp-506
5. Weissman, I. Hood, L. Wood, W. 1978. Essential Concepts in Immunology, the Benjamin/Cummings, California, pp-165.
6. Hood, L. Weissman, I. Wood, W. Wilson, J. 1984. Immunology (Second Edition), the Benjamin/Cummings, California, pp-558.
7. Coica, R and Sunshine, G. 2009. Immunology A Short Course (Sixth Edition), John Wiley & Sons, USA, pp-391.
8. Doan, T. Melvold, R. Viselli, S. *et al*., 2013. Immunology (Second Edition), Lippincott Williams & Wilkins, Maryland, pp-376.
9. Owen, J. A. Punt, J. Stanford, S. A. 2013. Kuby Immunology (7th Edition), Macmillan, England, pp692.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**2**	**1**	**1**	**2**	**1**
CO2	**3**	**3**	**2**	**2**	**1**	**2**	**1**
CO3	**2**	**3**	**3**	**2**	**2**	**2**	**2**
CO4	**2**	**3**	**3**	**3**	**2**	**3**	**2**
Total Score	**10**	**11**	**10**	**8**	**6**	**9**	**6**

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

Cos	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	**2**	**2**	**1**	**1**	**3**	**2**	**1**
CO2	**2**	**3**	**2**	**2**	**3**	**2**	**1**
CO3	**2**	**3**	**3**	**2**	**3**	**2**	**2**

CO4	**2**	**2**	**3**	**3**	**3**	**3**	**2**
Total Score	**8**	**10**	**9**	**8**	**12**	**9**	**6**

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	ECOLOGY	CORE	5	-	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the ecological principles, habitat, niche, population dynamics, community structure and ecosystem functioning.
CO2 (K3)	Apply ecological concepts to analyze species interactions, biodiversity patterns and environmental issues.
CO3 (K4)	Analyze ecosystem processes, biogeographical distribution, ecological succession and population regulation mechanisms.
CO4 (K5 & K6)	Evaluate conservation strategies, biodiversity management approaches and environmental sustainability practices for ecosystem protection.

Unit I

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

Unit II

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

Unit III

Species interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis. Community ecology: Nature of communities;

community structure and attributes; levels of species diversity and its measurement; edges and ecotones. Ecological succession: Types; mechanisms; changes involved in succession; concept of climax

Unit IV

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

Unit V

Applied ecology: Environmental pollution; global environmental change; biodiversity-status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches - Waste management. Conservation biology: Principles of conservation, major approaches to management, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

Reading list

1. Sharma, P.D. 2009. Ecology and Environment, Rastogi Publication, India, pp-616.
2. Calabrese, E.J. 1978. Pollutants and High-Risk Groups, John Wiley, pp-286.
3. Raven, P.H. and L.R. Berg, G.B. Johnson, 1993. Environment, Saunders College Publishing, pp-579.
4. Cunningham, W. P. and B. W. Saigo, 1999. Environmental Science, McGraw Hill Boston, 5th Edition.
5. Online courses.nptel.ac.in / noc 19 - g e 23/preview Classcentral.com/course/swayam

ecology - and environment – 14021.

Recommended texts

1. Odum, E.P. 1893. Basic Ecology, Saunders & Co., Philadelphia, pp-383.
2. Barthwl, R.R. 2002. Environmental Impact Assessment, New Age International Publishers, New Delhi, India, pp-425.
3. United Nations Environment Programme (UNEP). 1995. Global Biodiversity

Assessment, Cambridge University Press, pp-1140.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	2	2	1
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	3	3	2
Total Score	10	11	9	8	8	9	6

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	1	1	2	1	2	1
CO2	3	2	2	3	2	2	1
CO3	2	2	3	3	2	2	2
CO4	3	2	3	3	3	3	2
Total Score	11	7	9	11	8	9	6

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	LAB COURSE IN IMMUNOLOGY & ECOLOGY	CORE	-	4	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Demonstrate knowledge of immune cells, lymphoid organs, immunological techniques, ecological concepts and environmental parameters.
CO2 (K3)	Apply laboratory and field techniques for immunological analysis, water quality assessment and ecological investigations.
CO3 (K4)	Analyze immunological reactions, plankton diversity, ecosystem productivity and ecological interactions using experimental data.
CO4 (K5 & K6)	Evaluate ecosystem health, environmental quality and immunological responses through interpretation of laboratory and field observations.

IMMUNOLOGY

1. Identification of Lymphoid organs in rat / chick – dissections.
2. Identification of various types of immune cells in peripheral blood smear.
3. Observation of WBCs.
4. Single radial immuno diffusion technique
5. Double immune diffusion
6. Agglutination titer – Determination of agglutination titer

Spotters / Charts / Models

1. ELISA
2. Western Blot, Southern Blot
3. HIV, Malaria, TB
4. IgG, IGM, IgA – Immuno globulin – Types
5. Lymphocytes – T & B Cells

ECOLOGY

1. Measurement of primary productivity in relation to biomass.
2. Estimation of dissolved O2 and Carbondioxide in the given water samples.
3. Estimation of salinity and total alkalinity
4. Identification of fresh water / Marine planktons
5. Estimation of pH in different water samples
6. Visit and field study report on a pond/ forest / marine ecosystem (any one).

Spotters / Charts / Models

- Commensalism, Mutualism, Parasitism, food web, Inter specific and Intra specific competitions, Ecological Pyramid of number, Biomass and energy.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	2	2	1
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	3	2	2
Total Score	10	11	9	8	8	8	6

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	3	1	1	2	2	1
CO2	2	3	2	2	2	2	1
CO3	2	3	3	3	2	2	2
CO4	2	2	3	3	3	3	2
Total Score	8	11	9	9	9	9	6

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	MICROBIOLOGY	ELECTIVE -X	4	-	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand microbial diversity, classification, physiology, nutrition and microbiological techniques.
CO2 (K3)	Apply microbiological methods, culture techniques, staining procedures and sterilization practices for the isolation, cultivation, identification and characterization of microorganisms.
CO3 (K4)	Analyze the role of microorganisms in food production, food spoilage, industrial processes, biodegradation, biofertilizer production, waste management and environmental sustainability.
CO4 (K5 & K6)	Evaluate the significance of microorganisms in human health, industry and environment, and formulate appropriate strategies for the prevention, control and management of microbial diseases and their applications in biotechnology.

Unit I

History and scope of Microbiology - Theory of spontaneous generation – Germ theory of diseases - Koch's postulates - Microbial interactions - Whittaker's five kingdom approach – Carl Woese's three domains concept - Microbes and their types, Viruses, Bacteria, fungi and protozoans – Morphology and classification. Abnormal forms of bacteria, archaebacteria, Mycoplasma and PPLO, Recent trends in microbial taxonomy.

Unit II

Microbial Physiology: Nutritional Requirements and nutritional types of Microbes- - Nutrient transport mechanisms- Passive diffusion, Facilitated diffusion, Active transport, Group translocation and Specific transport system; Types of culture media- Selective, enrichment and differential media. Microbiological techniques: Microbiological Media- Types and composition of media -Sterilization techniques - Methods of pure culture

technique- Staining methods – Simple, Differential and Special staining.

Unit III

Food Microbiology - Normal microbial flora of common food – food infection – food poisoning – food preservation – microbiology of milk and milk products – Bakery products – Detection of food borne pathogens – food sanitation – food control agencies – food spoilage – ISI and BIS regulations for packaged drinking water.

Unit IV

Industrial Applications of Microbial Enzymes – Bioreactors and Types –Biopolymers – Biosurfactants – Biofertilizers, Bioleaching of metals - Biodegradation using microbial communities -Xenobiotics and Heavy metals degradation in water and soil –Sewage sludge treatment and utilization; Bioconversion of cellulosic wastes into protein and fuel.

Unit V

Microbial diseases - Causative agents, Mode of transmission, Symptoms, Prevention & Control - Protozoan diseases: Plasmodium, Entamoeba. Fungal diseases: Mycosis - Mycotoxicosis. Bacterial diseases: Tuberculosis (TB) –Typhoid - Viral diseases: Chicken pox, Hepatitis B, AIDS, Corona and Dengue.

Reading list

1. Dubey RC and Maheswari DK (2012). A Text of Microbiology (Revised edition). S. Chand and Company Ltd., New Delhi.
2. PelczarTR M J Chan ECS and Kreig N R (2006). Microbiology. Fifth edition, Tata McGraw-Hill INC. New York.
3. GeetaSumbali and Mehrotra RS (2009). Principles of Microbiology. First edition, Tata McGraw Hill P. Ltd., New Delhi.

Recommended texts

1. Prescott L M, J P Harley and DA Klein (2005). Microbiology. Sixth edition, international edition, McGraw Hill.
2. Stanier R, Ingraham J, Wheelis M and Painter P (2014) General Microbiology. 5th Edition, Macmillan Press.
3. Kathleen Park Talaro and Barry Chess Foundations in Microbiology10th Edition.

2018. Mc Graw Hill Education Publishers, USA.

4. Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Microbiology: An Introduction, 12th Edition (2017) Pearson publishers, USA

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	1	2	1
CO3	2	3	3	2	2	2	2
CO4	2	3	3	2	2	3	2
CO5	2	2	3	3	3	3	2
Total Score	12	13	12	10	9	12	8

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	1	1	2	2	1
CO2	2	3	2	2	2	2	1
CO3	2	3	3	3	2	2	2
CO4	2	2	3	3	3	2	2
CO5	2	2	3	3	3	3	3
Total Score	10	12	12	12	12	11	9

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	AQUACULTURE	SKILL ENHANCEMENT COURSE	4	-	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand the principles, scope and significance of freshwater, brackish water and marine aquaculture, including pond management and water quality requirements.
CO2 (K3)	Apply hatchery, breeding, seed production, feed formulation and live feed culture techniques for sustainable aquaculture practices.
CO3 (K4)	Analyze culture technologies of fish, shrimp, oyster, crab and seaweed, and evaluate factors influencing their production and management.
CO4 (K5 & K6)	Evaluate disease management strategies, ornamental fish culture practices and the role of aquaculture research organizations in promoting sustainable aquaculture development.

Unit I

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 for culture practice. Topography, site selection - soil condition and quality –pond design and layout -. Water quality management – Temperature, Salinity, Nutrients, O_2, pH). Control of parasites, predators and weeds in culture ponds. Fish farm implements - Secchi disc - aerator - pH meter - feeding trays – Fishing gears used in aqua farming.

Unit II

Procurement of seed from natural resources- collection methods and segregation. Hatchery technology for major carps and freshwater prawn. Artificial breeding under controlled conditions, induced breeding techniques, hypophysation, larval rearing, packing

and transportation. Commercial substitute for pituitary extracts. Classification of fish feed –Types of Artificial Feed - formulation - feeding methods. Live feed- Culture of Microalgae, Spirulina, Nostoc, Rotifer, Artemia.

Unit III

Shrimp hatchery technology - Hatchery design, brood stock management, spawning, larval rearing, Shrimp developmental stages, packaging and transportation. Culture technology - extensive culture methods semi- intensive - intensive culture methods - Bio floc technology - Culture operations (water quality, feed and health management) - harvesting, processing and marketing. Brackish water fish culture. Edible and Pearl oyster culture - pearl production. Crab culture. Economic importance of Lobster, Sea urchin and Sea cucumber - their by-products. Types of Seaweeds - species and methods of culture – by-products

Unit IV

Fish and Shrimp diseases and health management – infectious diseases – Bacterial: Dropsy, Erythroderma – Fungal: Branchiomycosis (Gill rot), Aspergillomycosis – Viral: Epizoatic Ulcerative Syndrome, Viral Hemorrhagic Septicaemia (VHS) – Protozoan: Ichthyopthiriasis (White Spot Disease), Myxozoans (Whirling Disease); Non-infectious - environmental and nutritional diseases. Diseases diagnosis, prevention and control measures.

Unit V

Types of ornamental fishes (freshwater and marine), their breeding behavior and biology. Oviparous, Ovo-viviparous and Viviparous fishes. Setting and maintenance of freshwater Aquarium tanks. Central aquaculture research organizations- CMFRI, CIBA, CIFT, CIFA, CIFE, ICAR-NBFGR, RGCA, MPEDA and its activities.

Reading list

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

Recommended texts

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).

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	2	1	1	1	2	1
CO2	3	3	2	2	2	2	2
CO3	2	3	3	2	2	2	2
CO4	2	3	3	3	3	3	3
Total Score	10	11	9	8	8	9	8

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	2	2	1	2	1	2	1
CO2	2	3	2	2	2	2	2
CO3	2	3	3	3	2	2	2
CO4	2	2	3	3	3	3	3
Total Score	8	10	9	10	8	9	8

COURSE CODE	COURSE NAME	CATEGORY	L	P	T
	LAB COURSE IN MICROBIOLOGY & AQUACULTURE	ELECTIVE	-	2	-

Course Outcomes

Upon completion of this course, students could

CO	Course Outcome Statement
CO1 (K1 & K2)	Understand laboratory safety practices, sterilization methods, microbial culture techniques, staining procedures, water quality parameters, fish pathology and aquaculture-related methodologies.
CO2 (K3)	Apply microbiological and aquaculture techniques including media preparation, microbial culturing, milk quality testing, water quality analysis, fish population estimation, morphometric studies, and age determination
CO3 (K4)	Analyze microbial growth patterns, antibiotic sensitivity results, primary productivity, fish population dynamics and taxonomic features of cultivable fish and prawn species
CO4 (K5 & K6)	Evaluate microbiological and aquaculture data and develop scientific interpretations for microbial quality assessment, aquatic ecosystem management, fish health monitoring, and sustainable aquaculture practices.

Microbiology Practicals

1. Safety hygiene in the laboratory with sample handling for microbial studies.

2. Cleaning of glasswares and modes of sterilization.

3. Preparation of culture media for microorganisms and culture of bacteria in agar plates.

4. Counting of viable cells (CFU/ml) by serial dilution and spread plate or pour plate technique.

5. Measurement of microbes using ocular and stage micrometer.

6. Differential staining

7. Test for antibiotic sensitivity.

8. Qualitative analysis of milk – methylene blue reductase test

9. Observation of algae and fungi.

Aquaculture Practicals

Practicals

1. Morphometry of a pond

2. Estimation of fish population using mark and recapture method

3. Estimation of primary productivity of macrophyte

4. Physical chemical analysis of dissolved oxygen, salinity and alkalinity in any two water samples

5. Study of fish pathology

6. Taxonomic description of cultivable fishes(Indian major carps, 3exotic carps, Heteropneustes fossilis, Oreochromis mossambicus

7. Morphological feature of paenaid and non paenaid prawn

8. Determination of age of fishes.

CO – PO Mapping

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	3	3	3	1	2	1	2
CO2	3	3	3	2	2	2	2
CO3	3	2	3	1	2	1	2
CO4	3	2	3	2	2	2	2
Total Score	12	10	12	6	8	6	8

Level of Correlation: 3 – High; 2 – Medium; 1 – Low; 0 – No Correlation

CO – PSO Mapping

COs	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CO1	3	3	3	2	2	2	3
CO2	3	3	3	2	2	2	3
CO3	3	3	3	3	2	2	3
CO4	3	3	3	3	2	3	3
Total Score	12	12	12	10	8	9	12