KAMARAJ COLLEGE

(AUTONOMOUS)

Accredited with A+ Grade by NAAC

Among Top 150 Colleges in India - NIRF Ranking 2025

இந்து நாடார் சங்கங்களால் 1966-ல் தொடங்கப்பட்ட கல்லூரி

(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)

THOOTHUKUDI - 628 003.

M.Sc., Zoology

Semester - I to IV

(for the students those who joined from the academic year 2025-2026)

KAMARAJ COLLEGE
(AUTONOMOUS)
Accredited with A+ Grade by NAAC
Among Top 150 Colleges in India - NIRF Ranking 2025
இந்து நாடார் சங்கங்களால் 1966-ல் தொடங்கப்பட்ட கல்லூரி
(Affiliated to Manonmaniam Sundaranar University, Tirunelveli)
THOOTHUKUDI - 628 003.

M.Sc., Zoology

Semester – I to IV

SYLLABUS

(for the students those who joined from the academic year 2025-2026)

Department Profile

Name of the Programme M.Sc., Zoology

Programme code 07013

Year of Establishment 1992

Vision:

Aim to empower students with a deep understanding of the biological sciences, critical thinking skills, and a passion for exploring the wonders of the animal kingdom.

Mission:

To provide students with a comprehensive education in zoology, emphasizing critical thinking, scientific literacy, and hands-on experience. We aim to inspire students to become informed, engaged, and compassionate citizens, equipped to address the complex challenges facing our planet's biodiversity

College Mail ID kamarajcoll@gmail.com

College Website www.kamarajcollege.ac.in

Postgraduate Degree Programme

1. Introduction

Programme Outcome, Programme Specific Outcomes and Course Outcomes. Students completing this programme will be able to present their core undergraduate discipline clearly and precisely, make abstract ideas precise by formulating them in the language of the specific discipline, and describe related ideas from multiple perspectives and explain fundamental concepts. Completion of this programme will also enable the learners to join the teaching profession, enhance their employability for government jobs, jobs in various other public and private enterprises

Eligibility:

Students must have passed B. Sc., in zoology from a recognized university and College.

Programme: M.Sc. (Zoology):	**Duration: 2years**
Programme outcomes (PO) The M.Sc. Zoology program is designed to achieve the following objectives	
PO 1	**Problem Solving Skill** Apply knowledge of Management theories and Human Resource practices to solve business problems through research in Global context.
PO 2	**Decision Making Skill** Foster analytical and critical thinking abilities for data-based decision-making.
PO 3	**Ethical Value** Ability to incorporate quality, ethical legal Value based Perspectives and all organizational activities.
PO 4	**Communication Skill** Ability to develop communication, managerial and interpersonal skills.
PO 5	**Individual and Team Leadership Skill** Capability to lead themselves and the team to achieve organizational goals.
PO 6	**Employability Skill** In calculate on temporary business practices to enhance employability skills in the competitive environment.
PO 7	**Entrepreneurial Skill** Equip with skills and competencies to become an entrepreneur.
PO8	**Contribution to Society** Succeed in career endeavors and contribute significantly to society.

Program Specific Outcomes (PSO)

	On successful completion of the M.Sc.(Zoology) program, the students are expected to
PSO1	**Placement** To Prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, believes and apply diverse frames of reference to decisions and actions.
PSO2	**Entrepreneur** To Create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations.
PSO3	**Research and Development** To Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development.
PSO4	**Contribution to Business World** To Produce employable, ethical and innovative professionals to sustain in the dynamic business world.
PSO5	**Contribution to the Society** To Contribute to the development of the society by collaborating with stake holders for mutual benefit.

Methods of Evaluation		**Marks**	
Internal Evaluation	Continuous Internal Assessment Test	15	25
	Assignment (PPT) and Seminar	5	
	Group Discussion and Viva	5	
External Evaluation	End Semester Examination		75
Total			**100**

Total credits Under–Graduate Courses including Lab Hours – 2024 to 2025

Semester	Hours	Credits	Additional Credits
I	30	20	2
II	30	22	2
III	30	26	2
IV	30	26	2
Total		**94**	**8**

****Extra Credit will be given on the basis of student's performances**

Written Examination: Theory Paper (Bloom's Taxonomy based)

Question paper Model Assessment Pattern

Continuous Internal Assessment (CIA) & End Semester Examination (ESE)

- CIA : 25
- ESE:75

Theory Course:

For theory courses there shall be two tests conducted by the faculty concerned and the average of the best two can be taken as the Continuous Internal Assessment (CIA).CIA is for 30 marks max and will be converted in to 15 marks. The duration of each test shall be 1 ¼ Hrs.

Continuous Internal Assessment (Writing)	15 marks
Assignment (PPT) & Seminar	5 marks
Viva & Group Discussion	5 marks

For theory Papers:

- Part A (10×1=10) Marks-Answer all questions (Multiple choice)
- Part B (5×5=25) Marks-Choosing either(a) or (b)
- Part C (5×8=40) Marks-Choosing either (a) or (b)

Total =75 marks

Laboratory Courses Assessment

- CIA-40marks
- ESE-60marks
- Mandatory Record submission, attendance and class participation.
- Two CIA for 40 marks max. The average of the best two can be taken as the Continuous Internal Assessment.
- The duration of each test shall be 3 hours. In order to avoid pull the score down of each PO, it is suggested that the usage L-Low (1) to the minimum. The S, M, L is based on the Course outcomes. The mapping is based on the revised Bloom's

Taxonomy Verbs used to describe your Course outcomes.

- Remember and Understanding–Lower level
- Apply and Analyze– Medium Level
- Evaluate and Create–Strong Level

Written Examination: Theory Paper (Bloom's Taxonomy based) Question Paper Model

Assessment Pattern

Continuous Internal Assessment (CIA) & End Semester Examination (ESE)

- **CIA: 25**
- **ESE: 75**

Theory Course:

For theory courses, there shall be two tests conducted and the average of the best two can be taken as the Continuous Internal Assessment (CIA). CIA is for 30 marks max and will be converted into 15 marks. The duration of each test shall be 1 ¼ Hrs.

Continuous Internal Assessment (Writing)	15 marks
Assignment (PPT) & Seminar	5 marks
Group Discussion or Viva	5 marks
Total marks	25 marks

For Theory Papers: End Semester Examinations

1.	Part A	10X1=10 Marks (MCQ)
2.	Part B	5 X 5= 25 Marks- Choosing either (a) or (b)
3.	Part C	5X 8=40 Marks-Choosing Either (a) or (b)
	Total marks	75 marks
The duration of each test shall be 3 hours		

Laboratory Courses Assessment

CIA - 40 marks

ESE - 60 marks

- Mandatory Record submission, attendance, and class participation.
- Two CIA for 40 marks max, the average of the best two can be taken as the Continuous internal marks.

Written Examination: Theory Paper (Bloom's Taxonomy based) Question paper Model

Internal & External Assessment - 25% CIA & 75% external assessment (End-Semester examination)

1. Testing Pattern (25+75)
2. CIA-25marks, External- 75 marks

Theory Course:

For theory courses there shall be two tests conducted and the maximum of 50, which will be converted to 15 marks. The average can be taken as the Continuous Internal Assessment (CIA) 25 marks. The duration of each test shall be two hours.

Consolidated internal marks

Internal I–15	Average=15Marks
Internal II–15	
Assignment (PPT) & Seminar	5
Group Discussion & Viva	5
Total Internal Marks	25

For theory Papers:

- Part A 10 X 1= 10 Marks – Answer all questions (No Choice)
- Part B 5 X 5 = 25 Marks- Choosing either (a) or (b)
- Part C 5 X 8 = 40 Marks- Choosing either (a) or (b)

Total =75marks

Laboratory Courses:

- **Internal - 40 marks**
- **External - 60 marks**

For Laboratory Courses, there shall be Continuous Internal Assessment Test and Record. One test in Laboratory part, attendance and class participation.
The CIA for a maximum of 40 marks.

Pedagogy:

- Technology Based Learning (PPT)
- Peer Teaching (Chalk & Talk)
- Virtual Lab
- Blended Learning (Online & Offline)
- Group Learning
- Self - Study
- Games Based Learning

Course Structure for Science Stream
First Year – Semester – I
M.Sc., Zoology
(With effect from the academic year 2025 – 2026 onwards)

Semester I	Course Code	Name of the Course	Hours / Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Core-I	25PMZO11	Structure and Function of Invertebrates	**7**	**5**	**3**	**25**	**75**	**100**
Core-II	25PMZO12	Comparative Anatomy of Vertebrates	**7**	**5**	**3**	**25**	**75**	**100**
Core Lab-1	25PMZOL1	Practical - Lab Course in Invertebrates & Lab course in Vertebrates	**6**	**4**	**3**	**40**	**60**	**100**
Elective-I Discipline Centric	25PEZO11	Biochemistry	**5**	**3**	**3**	**25**	**75**	**100**
Elective-II Generic:	25PEZO13	Economic Entomology	**5**	**3**	**3**	**25**	**75**	**100**
Total			**30**	**20**				

****EC–Elective Course** ****ESE- End Semester Examination**
****CIA- Continuous Internal Assessment**

Course Structure for Science Stream
First Year – Semester – II
M.Sc., Zoology
(With effect from the academic year 2025 – 2026 onwards)

Semester II	Course Code	Title of the Course	Hours /Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Core-III	25PMZO21	Cellular and Molecular Biology	6	5	3	25	75	100
Core-IV	25PMZO22	Developmental Biology	6	5	3	25	75	100
Core Lab - 2	25PMZOL2	Cellular and Molecular Biology & Developmental Biology Lab	6	4	3	40	60	100
Elective–III Discipline Centric	25PEZO21	Biostatistics	4	3	3	25	75	100
Elective-IV Generic:	25PEZO23	Research Methodology	4	3	3	25	75	100
SEC - I	25PSZO21	Poultry Farming	4	2	3	25	75	100
		Total	**30**	**22**				

****SEC- Skill Enhancement Course** ****CIA- Continuous Internal Assessment**
****EC– Elective Course** ****ESE- End Semester**

Course Structure for Science Stream
Second Year – Semester – III
M.Sc., Zoology
(With effect from the academic year 2025– 2026 onwards)

Semester III	Course Code	Title of the Course	Hours /Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Core-V	25PMZO31	Genetics and Evolution	6	6	3	25	75	100
Core-VI	25PMZO32	Animal Physiology	6	6	3	25	75	100
Core Lab-3	25PMZOL3	Lab in Genetics and Evolution and Animal Physiology	6	6	3	40	60	100
Core – VII Discipline Centric (Industry Module)	25PMZO33	Medical Lab Technology	4	2	3	25	75	100
EC-VI Generic:	25PEZO32	Applied Microbiology	4	2	3	25	75	100
SEC- II	25PSZO31	Dairy Farming	4	2	3	25	75	100
Training	25PTZO31	Internship / Industrial visit / Field visit / Research Knowledge updation activities	-	2	-	40	60	100
		Total	**30**	**26**				

****SEC- Skill Enhancement Course** ****CIA- Continuous Internal Assessment**
****EC– Elective Course** ****ESE- End Semester**

Course Structure for Science Stream
Second Year – Semester – IV
M.Sc., Zoology
(With effect from the academic year 2025 – 2026 onwards)

Semester IV	Course Code	Title of the Course	Hours /Week L/P	Credit	Duration of ESE (Hrs.)	Marks Allotted		
						CIA	ESE	Total
Core-VII	25PMZO41	Immunology	6	6	3	25	75	100
Core-VIII	25PMZO42	Ecology	6	6	3	25	75	100
Core - IX	25PMZOP1	Project	6	6	3	50	50	100
Core Lab-4	25PMZOL4	Lab Course in Immunology and Ecology	4	3	3	40	60	100
EC– VII Discipline Centric	25PEZO41	Aquaculture	4	2	3	25	75	100
SEC - III	25PSZO41	Forensic Science	4	2	3	25	75	100
Extension Activity	25PEA41	Pollution Awareness Literacy / Voluntary Services	-	1	3	25	75	100
		Total	**30**	**26**				

**** SEC-Skill Enhancement Course** **** CIA- Continuous Internal Assessment**
**** EC –Elective Course** **** ESE- End Semester Examination**

Semester - I

Structure and Function of Invertebrates

Title of the Course		**Structure and Function of Invertebrates**			
Course Type		**Core Course-I**			
Course Code		**25PMZO11**			
Year	**I**	**Semester**	**I**	**Credits**	**5**
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**
		5	**2**	**-**	**7**

Learning Objectives	
LO1	To understand the concept of classification and their characteristic features of Major group of invertebrates.
LO2	To realize the range of diversification of invertebrate animals
LO3	To enable the students to find out the ancestors or derivatives of any taxon.
LO4	To know the functional morphology of system biology of invertebrates.
LO5	Record / Observation Note (Submission Is Mandatory)

Course outcomes	**On completion of this course, students will be able to:**
CO1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.
CO2	Understand the evolutionary process. All are linked in a sequence of life patterns.
CO3	Apply this for pre-professional conservation of life forms.
CO4	Analyze what lies beyond our present knowledge of life process.
CO5	Evaluate and to create the perfect phylogenetic relationship in Classification.

UNIT: 1 **18 Hours**

Structure and function of invertebrates: Principles of Animal taxonomy; Species concept; International code of zoological nomenclature; Taxonomic procedures; new trends in taxonomy

UNIT: 2 **18 Hours**

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

UNIT: 3 **18 Hours**

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

The Role of Insects in Indian Traditional Medicine:

Bees and their products (honey, wax) are used for their medicinal properties. Silkworms (*Bombyx mori*) are important in traditional healing practices.

UNIT: 4 **18 Hours**

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

UNIT: 5 **18 Hours**

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

Extended professional component (is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC /TRB/NET/UGC-CSIR/GATE/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional competency, Professional communication and Transferrable skill.

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

Web Resources:	
1	https://deb.ugc.ac.in/Uploads/SelfLearning/HEI-P-U-0482/HEI-P-U-0482_SelfLearning20230331142843.pdf
2	https://byjus.com/biology/invertebrates/
3	www.dnyanopasak.org.in/new/images/18-_19/ProgramOutcome_PGzoology.pdf
4	www.scienceaz.com/main/Download/resource/saz/id/2239/unitId/61/format/single

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	3	2	3
CO2	3	3	2	2	3	3	2	2
CO3	3	2	2	2	3	3	2	2
CO4	3	2	2	2	3	3	2	2
CO5	3	2	2	2	3	3	2	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Comparative Anatomy of vertebrates

Title of the Course		**Comparative Anatomy of Vertebrates**			
Course Type		**Core Course-II**			
Course Code		**25PMZO12**			
Year	**I**	**Semester**	**I**	**Credits**	**5**
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**
		5	**2**	**-**	**7**

Learning Objectives	
LO1	Exemplifying the vertebrate origin and the intermediary position of Prochordates between invertebrates and vertebrates.
LO2	Acquires the knowledge on evolution and adaptive radiation of Agnatha and Pisces.
LO3	Understanding knowledge about the first terrestrial vertebrates and the adaptive radiation of land animals
LO4	Imparting conceptual knowledge about the animal life in the air and their behaviour.
LO5	Understanding the origin and efficiency of mammals and evolutionary changes that occurred in the life of vertebrates.
Course outcomes	**On completion of this course, students will be able to:**
CO1	Remember the general concepts and major groups in animal classification, origin, structure, functions and distribution of life in all its forms.
CO2	Understand the evolutionary process. All are linked in a sequence of life patterns.
CO3	Apply this for pre-professional conservation of life forms.
CO4	Analyze what lies beyond our present knowledge of life process.
CO5	Evaluate and to create the perfect phylogenetic relationship in Classification.

Unit: I 18 Hours

Origin of vertebrates: Concept of Protochordata; The nature of vertebrate morphology; Definition, scope and relation to other disciplines; Importance of the study of vertebrate morphology.

Unit: II

Rep & Birds **18 Hours**

Classification of vertebrates; General structure and functions of skin and its derivatives; Glands, scales, horns, claws, nails, hoofs, Feathers and hairs.

Unit: III

Birds & Mammals **18 Hours**

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

Unit: IV

Mammals **18 Hours**

Skeletal system: Form, function, body size and skeletal elements of the body; Comparative account of jaw suspensorium, Vertebral column; Limbs and girdles; Evolution of Urinogenital system in vertebrate series.

Symbolism and Functional Anatomy in Mythology:

Symbolic meanings in Hindu and Buddhist traditions.: Example : Elephant and Birds

Unit: V

Mammals **18 Hours**

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

Extended professional component (is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC /TRB/NET/UGC-CSIR/GATE/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional competency, Professional communication and Transferrable skill.

Recommended Texts:	
1	Waterman, A.J.1972.Chordate Structure and Function, Mac Millan Co., New York, pp.587
2	Parker T.J. and W.A. Haswell.1962.A textbook 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, 4thEdition, Rastogi Publications, Meerut, pp-968.

References Books:	
1	SwayamPrabhahttps://www.swayamprabha.gov.in/index.php/program/archive/923.
2	Yong, J.Z.1981.The life of Vertebrates, English language Book society, London, pp645.
3	Romer, A.S.1971. The Vertebrate body, W.B.S. Saunders, Philade

Web Resources:	
1	https://deb.ugc.ac.in/Uploads/SelfLearning/HEI-P-U-0482/HEI-P-U-0482_SelfLearning_20230331142843.pdf
2	https://byjus.com/biology/invertebrates/
3	https://www.dnyanopasak.org.in/new/images/18-19/ProgramOutcome_PG_zoology.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	2	3	2	3
CO2	3	2	2	3	2	3	2	2
CO3	3	2	3	2	2	3	2	1
CO4	3	3	2	3	1	3	2	1
CO5	3	2	2	3	3	3	2	3

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Practical - Lab course in Invertebrates & Vertebrates

Title of the Course		**Practical - Lab Course in Invertebrates & Vertebrates**			
Course Type		**Core Course-III**			
Course Code		**25PMZOL1**			
Year	**I**	**Semester**	**I**	**Credits**	**4**
Instructional Hours Per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**
		-	**-**	**6**	**6**
Learning Objectives					
LO1	Understanding the different systems in invertebrates & vertebrates. Learning about various animal species, their phylogenetic affinities and their adaptive features. Imparting conceptual knowledge about the salient features and functional anatomy. Developing the skill in mounting Techniques of the biological samples. Gaining fundamental knowledge on the skeletal system.				
Course outcomes	On completion of this course, students will be able to:				
CO1	Understand the structure and functions of various systems in animals				
CO2	Learn the adaptive features of different groups of animals				
CO3	Learn the mounting techniques				
CO4	Acquire strong knowledge on the animal skeletal system				

Invertebrates

Dissection/Virtual

Earthworm : Nervous system
Pila : Digestive and nervous systems
Sepia : Nervous system
Cockroach : Nervous system
Grasshopper : Digestive system and mouth parts
Prawn : Appendages, nervous and digestive systems
Crab : Nervous system

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

1. *Amoeba*
2. *Endamoeba histolytica*
3. *Paramecium*
4. Hydra with bud
5. Sporocyst–Liver fluke
6. *Cercaria larva*
7. Tapeworm (*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 : Mouthparts
Grasshopper: Mouth parts

Chordates

Study the nervous system of Indian dogs hark – Dissection / Virtual

1. Nervous system of *Scoliodon laticaudatus* –5th or Trigeminal nerve
2. Nervous system of *Scoliodon laticaudatus*– 7th or Facial nerve
3. Nervous system of *Scoliodon laticaudatus* –9th and10th 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 dogs hark)
4. *Trygon sp.* (Stingray)
5. *Torpedo sp.* (Electric ray)
6. *Arius maculatus* (Cat fish)
7. *Belone cancila* (Flute fish)
8. *Exocoetus poecilopterus* (Flying fish)
9. *Mugil cephallus* (Mullet)
10. *Tilapia mossambicus* (Tilapia)
11. *Rachycentron canadum* (Cobia)
12. *Tetrodon punctatus* (Puffer fish)
13. *Dendrophis sp.* (Tree snake)

Study of the different types of scales in fishes

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

Study of the frog skeleton system (Representative samples)

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

Mounting

1. Weberian ossicles of fish

Text Books:

1. Lal, S.S.2009. Prac1tical 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.

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	3	2	3	3	2	3
CO2	3	2	2	3	2	3	2	2
CO3	2	2	2	3	3	3	2	2
CO4	3	3	3	3	3	3	2	3
CO5	3	2	2	2	3	3	2	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Biochemistry

Title of the Course		Biochemistry			
Course Type		Elective III			
Course Code		25PEZO11			
Year	I	Semester	I	Credits	3
Instructional Hours Per week		Lecture	Tutorial	Lab Practice	Total
		4	1	-	5

Learning Objectives	
LO1	**Students should know the fundamentals of Biochemistry.**
Course outcomes	**On completion of this course, students will be able to:**
CO1	Learn the structure, properties, metabolism, and bioenergetics of biomolecules.
CO2	Acquire knowledge on various classes and major types of enzymes, classification, their mechanism of action and regulation.
CO3	Understand the fundamentals of biophysical chemistry And biochemistry, importance, and applications of methods in conforming the structure of biopolymers
CO4	Comprehend the structural organization of and proteins, carbohydrates, nucleic acids and lipids
C05	Familiarize the use of methods for the identification, characterization, and conformation of biopolymer structures.

Unit: **I** **15 Hours**

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 **15 Hours**

Bio molecular 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 **15 Hours**

Bioenergetics and enzymology: Bioenergetics, glycolysis, oxidative phosphorylation, Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis as enzymes

Unit: IV **15 Hours**

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), tRNA, micro- RNA).

Unit: V **15 Hours**

Stabilizing interactions in biomolecules: Stability of protein and nucleic acid structures - hydrogen bonding, covalent bonding, hydrophobic interactions, and disulfide linkage.

Indian Medicinal Plants and Biochemical Research:

- Tulsi (*Ocimum sanctum*)
- Neem (*Azadirachta indica*)

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

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.
Reference books:	1. Buchanan, B.B., W. Gruissem and R.L. Jones. 2015. Biochemistry and Molecular Biology of Plants. John Wiley and Sons Ltd., UK, pp-1280. 2. Murray, R.K., D.K. Granner, P.A. Mayes and V.W. Rodwell. 2003. Harper's Illustrated Biochemistry (26thEdition), 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.andJ.G.Voet.2011.Biochemistry.(4thEdition). John Wiley& Sons (Asia) Pvt.Ltd. pp-1428.

Web Resources:	
1	www.dcrustlms.in/upload/AA095-14-Upadhyay%20_%20Biophysical%20Chemistry.pdf
2	www.yourarticlelibrary.com/notes/biophysical-chemistry-short- notes-on-the- principles-of-biophysical-chemistry/22744
3	https://dkmcollege.in/wp-content/uploads/2023/08/1.1.3-184.pdf
4	https://www.studocu.com/in/document/amrita-vishwa-vidyapeetham/csir- preparation/csir-unit-1-full-notes/33890284

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	3	2	3	2	3
CO2	3	3	2	3	3	3	2	2
CO3	2	2	2	3	2	3	3	3
CO4	3	2	3	2	3	2	3	3
CO5	2	3	3	2	2	3	2	3

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Economic Entomology

Title of the Course		Economic Entomology			
Course Type		Elective III			
Course Code		25PEZO13			
Year	I	Semester	I	Credits	3
Instructional Hours Per week		Lecture	Tutorial	Lab Practice	Total
		4	1	-	5

Learning Objectives	
LO1	Students should acquire a good understanding about the life of insects and their classification.
Course outcomes	**On completion of this course, students will be able to:**
CO1	Understand taxonomy, classification, and life of insects in the animal kingdom
CO2	Know the lifecycle, rearing and management of diseases of beneficial insects.
CO3	Know the type of harmful insects, lifecycle, damage Potential and management to pests including natural pest control
CO4	Recognize insects which act as vectors causing diseases in animals and human
C05	Overall understanding on the importance of insects in human life.

Unit: I 15 Hours

Scope and history of Entomology- branches of Entomology– Types of insect mouth Parts, legs, and antenna. Metamorphosis of insect. 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 15 Hours

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 15 Hours

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, stored grains and cereals.

Unit IV 15 Hours

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.

Traditional Pest Management (Nisarga Chikitsa):

- Cow Urine
- Neem (*Azadirachta indica*)

Unit: V 15 Hours

Vector biology: Vectors of veterinary and public health importance- Mosquitoes as potential vectors of human disease- control measures. Man, and insects: The value of insects – insects as protein sources of human and animal feeds. Medical Entomology: Medicinal use of insects. Forensic Entomology

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Chapman, R.F., S.J. Simpson and A.E. Douglas. 2012. The Insects: Structure and Function, Fifth Edition, Cambridge University Press, pp-959. 2. Imms, A.D., O.W. Richards and R.G. Davies (Eds.) IMMS' General Textbook of Entomology, Volume I: Structure, Physiology and Development, pp-418; Volume 2: Classification and Biology, pp-934, Springer Netherlands. 3. Daly, H.V., J.T. Doyen and P.R. Ehrlich. 1978. Introduction to Insect Biology and Diversity. McGraw-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.
Reference books:	1. Ayyar, L.V.R. 1936. Handbook 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

Web Resources:	
1	www.jnkvv.org/PDF/30032020194912Fundamental%20of%20Entomology.pdf
2	www.rvskvv.net/images/I-Year-II-_Sem_Fundamentals_Entomology_b_20.04.2020.pdf
3	https://uou.ac.in/sites/default/files/slm/MSCZO-610.pdf
4	www.ars.usda.gov/ARSUserFiles/80420580/Collecting

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	2	3	2	3	2	2	2	3
CO2	3	3	2	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3
CO4	3	3	3	3	3	3	2	3
CO5	3	3	3	2	2	3	2	3

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester - II

Cellular and Molecular Biology

Title of the Course		**Cellular and Molecular Biology**					
Course Type		**Core - IV**					
Course Code		**25PMZO21**					
Year	**I**	**Semester**		**II**	**Credits**		**5**
Instructional Hours Per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	**2**		**--**	**6**	
Learning Objectives							
LO1	To understand the ultra-structures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.						
LO2	To realize involvement of various cellular components in accomplishing Cell division.						
LO3	To enable a successful performance in cell biology component of CSIR UGC NET.						
LO4	To understand the ultra-structures and functions of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.						

Course outcomes	On completion of this course, students will be able to:
CO1	Understand the general concepts of cell and molecular biology.
CO2	Visualize the basic molecular processes in prokaryotic and eukaryotic cells, especially relevance of molecular and Cellular structures influencing functional features.
CO3	Perceive the importance of physical and chemical signals at the molecular level resulting in modulation of response of cellular responses.
CO4	Updated the knowledge on the rapid advances in cell and molecular biology for a better understanding of onset of various diseases including cancer.
CO5	Understand the general concepts of cell and molecular biology.

Unit	Contents
I	General features of the cell: Basic structure of prokaryotic and eukaryotic cells. Protoplasm - cell organelles; cell theory; Variation in cellular morphology.
II	Cellular organization: Membrane structure and functions - Structure of model membrane, lipid bilayer and membrane proteins diffusion, osmosis, ion channels, active transport, ion pumps, mechanism and regulation of intracellular transport, electrical properties of membranes. Organization and roles of cellular organelles: Nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles and chloroplasts.
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, protein synthesis pathway in prokaryotic and eukaryotic cells; Genetic maps.
IV	Intercellular communication: Cell surface receptors for peptide and steroid hormones- signaling through G-protein coupled receptors, signal transduction pathways. General principles of cell communication: extracellular space and matrix, interaction of cells with other cells and non-cellular structures.
V	Cancer cells: Characteristics features of normal and cancer cells; Carcinogens: types and cancer induction; Metastasis; Oncogenes and tumor suppressor genes, apoptosis; strategies to inhibit cancer cell proliferation.

Extended professional component (is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC / TRB / NET / UGC – CSIR / GATE / TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional competency, Professional communication and Transferrable skill.

Recommended Texts:	
1	Karp, G. 2010 .Cell Biology (Sixth Edition), John Wiley & Sons, Singapore, pp-765.
2	Lodish, H., C. A.Kaiser, A. Bretscher, *etal*., 2013. Molecular Cell Biology (Seventh Edition),Macmillan,England,pp-1154
3	De Robert is, E.D.P. and E.M.F. DeRobertis Jr, 1987. Cell and Molecular Biology. Info-Med, Hong Kong, pp-734
4	Abbas, A. K.,A. H.Lichtmanand S. Pillai ,2007,Cell and Molecular Immunology (Sixth Edition), Saunders, Philadelphia,pp-566
References Books:	
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

Web Resources:	
1	https://www.cellmolbiol.org/
2	https://researchbysubject.bucknell.edu/c.php?g=25629&p=156817
3	https://www.ncbi.nlm.nih.gov/books/NBK21054/
4	https://guides.library.ucdavis.edu/molecular-and-cellular-biology

Mapping with Programme Outcomes and Programme Specific Outcomes

COs	PO1	PO2	PO3	PO4	P O 5	PO6	PO 7	PO8
CO1	2	3	2	2	3	3	3	2
CO 2	2	2	2	3	3	3	3	2
CO 3	3	3	3	2	2	3	2	2
CO 4	2	2	3	2	3	3	3	2
CO 5	3	2	2	3	3	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Developmental Biology

Title of the Course		Developmental Biology					
Course Type		Core - V					
Year	I	Semester	II	Credits	5	Course Code	25PMZO22
Instructional Hours Per week		Lecture	Tutorial		Lab Practice	Total	
		4	2		--	6	
Learning Objectives							
LO1	Understand the process of gametogenesis, cleavage and gastrulation, Embryonic development, extra embryonic membrane and placenta in various animals and human.						
LO2	Learn the principles, methods and applications of cryo-preservation of gametes and embryo.						
LO3	To enable a successful performance in Developmental Biology component of CSIR UGC NET.						
LO4	To learn the macromeres, mesomeres, and micromeres and know which cell types are derived from each of these cell layers in the early embryo (e.g. primary and secondary mesenchyme, ectoderm, endoderm, and mesoderm).						
LO5	Be able to learn how vertebrates gastrulate (frog, fish, chick, and mammal). Be able to compare and contrast the process of gastrulation in the various model organisms.						

Unit	Contents	Hrs.
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 insects and crustaceans; Genetic control of vitellogen in synthesis in amphibians.	**18**
II	Fertilization: Sperm aggregation, Sperm activation, Chemotaxis, Sperm maturation and capacitation in mammals, Acrosome reaction. Sperm – egg interaction. Sperm entry into the egg-Egg activation - Intracellular calcium release - Cortical reaction – Physiological polyspermy-Fusion of male and female pronuclei-Post fertilization metabolic activation – Parthenogenesis.	**18**
III	Cleavage and gastrulation: Pattern of embryonic cleavage, mechanisms of cleavage, mid blastula transition-Determinate and regulatory embryos, Factors affecting gastrulation, mechanisms and types of gastrulation in chick and mammals. Fate maps - Amphibian and Chick, Epigenesis and preformation – Formation of primary germ layers.	**18**
IV	Embryonic Development; Embryonic development of fish and birds, formation of extra embryonic membranes in 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.	**18**
V	Post embryonic development metamorphosis: Endocrine control of metamorphosis in insect and amphibian - Endocrine control of moulting and growth in crustaceans and insects - Neoteny and pedogenesis. Regeneration: Formation of ectodermal cap and regeneration blastoma–Types of regeneration in planaria, Factors stimulating regeneration – Biochemical changes associated with regeneration. Experimental Embryology: Mammalian reproduction: Mammalian reproductive cycle, Hormonal regulation, Cryopreservation of gametes/embryos - Ethical issues in cryopreservation.	**18**

Extended Professional Component (is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC/ TRB / NET / UGC–CSIR/GATE/TNPSC/others to be solved (To be Discussed during the Tutorial hour)
Skills acquired from this Course.	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

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 (3rdEdition), Wily-Blackwell Publications, USA, pp-496.
3	Mari-Beffa, M. and J.K night. 2005. Key Experiments in Practical Developmental Biology, Cambridge University Press, UK, pp-404.
References Books:	
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.

Web Resources:	
1	www.sdbonline.org/sites/archive/other/VLDBEducaRes.html
2	www.biologyonline.com/tutorials/developmental-biology
3	www.scribd.com/document/457024152/csir-unit-5-updated-pdf
4	https://bgc.ac.in/pdf/study-material/developmental-biology-7th-ed-sf-gilbert.pdf
5	https://mis.alagappauniversity.ac.in/siteAdmin/ddeadmin/uploads/2/PG_M.Sc Zoology_350%2021%20%20Developmental%20Biology%20and%20Evolution (1).pdf

Course outcomes	On completion of this course, students will be able to:
CO1	Define the concepts of embryonic development
CO2	Observe various stages of cell divisions under microscope
CO3	Understand the formation of zygote
CO4	Differentiate the blastula and gastrula stages
CO5	Learn the distinguishing features of three different germ layers and formation of various tissues and organs

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	3	3	2
CO2	3	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	2
CO4	3	3	3	3	3	2	3	3
CO5	3	3	3	2	3	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Cellular and Molecular Biology and Developmental Biology Lab

Title of the Course	**Cellular and Molecular Biology and Developmental Biology Lab**						
Course Type	**Core – IV - Lab - 2**						
Year	**I**	**Semester**	**II**	**Credits**	**4**	**Course Code**	**25PMZOL2**
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**			
	2	**-**	**4**	**6**			
Learning Objectives							
LO1	Practical course aims at demonstrating significant cellular and molecular biological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology, and developmental biology into practical understanding.						
Course outcomes: CO	**On completion of this course, the students will be able to**						
CO1	Acquire knowledge to differentiate the cells of various living organisms and become a wares of physiological processes of cells e.g. cell divisions, various stages of fertilization and embryo development.						
CO2	Understand and observe as well as correctly identify different cell types, cellular structures using different microscopic techniques.						
CO3	Develop handling- skills through the wet-lab course.						
CO4	Learn the method of culturing of *Drosophila* and identification of their wild and mutant strains.						
CO5	Acquire skills to perform human karyotyping and chromosome mapping to identify abnormalities.						

EXPERIMENTS

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. Agarosegel electrophoresis of DNA
10. SDS-Polyacrylamide gel electrophoresis

Developmental Biology

Gametogenesis –Observation of gametes from gonadal tissue sections

i. Oogenesis: Section through vary of shrimp, fish, frog and mammals

ii. Spermatogenesis: Section through testis of shrimp, fish, calotes and mammals Fertilization

iii. Induced spawning in polycheate worm *Hydroids elegans*

iv. *In vitro* fertilization and development in a polycheate worm *Hydroids elegans*

v. Observation of egg developmental stages in *Emerita emeritus* Embryogenesis

vi. Observation and whole mount preparation of the chick blastoderm -18 hours of development

vii. Chick embryonic stage- 24h ours of development

viii. Chick embryonic stage – 48 hours of development

ix. Chick embryonic stage- 72 hours of development

x. Chick embryonic stage-96 hours of development Histological observation: Section through various developmental stages in chick embryo Experimental Embryology: Regeneration in Frog Tadpoles

xi. Blastema formation

xii. Demonstration of regenerative process in tadpole Metamorphosis

xiii. Demonstration of metamorphosis in Frog Tadpole using exogenous Iodine Cryopreservation

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

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper).	Questions related to the above topics, from various competitive examinations UPSC / TRB/ NET / UGC – CSIR / GATE/ TNPSC /others to be solved(To be discussed during the Tutorial hour)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Cooper, G.M .and Adams, K., 2022. *Thecell: amolecular approach*. Oxford University Press.
Reference Books	1. Karp, G., 2009. *Cell and molecular biology: concepts and experiments*. John Wiley & Sons. 2. Pollard, T.D., Earnshaw, W.C. Lippincott-Schwartz, J. and Johnson, G., 2022. *Cell Biology E-Book: Cell Biology E-Book*. Elsevier Health Sciences.
Web resources	https://onlinecourses.nptel.ac.in/noc24_bt67/preview

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	2	3	3	3	2	3	3
CO2	3	3	3	3	2	3	3	2
CO3	3	3	2	3	3	3	3	2
CO4	2	2	3	2	3	3	3	3
CO5	3	3	2	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Research Methodology

Title of the Course	Research Methodology						
Course Type	Elective - IV						
Year	I	Semester	II	Credits	3	Course Code	25PEZO23
Instructional Hours per week	Lecture	Tutorial	Lab Practice	Total			
	3	1	-	4			

Learning Objectives	
LO1	Students understand the basic principles, methodology and applications of widely used instruments in biological sciences.
LO2	Student learn how to prepare research paper for publication in journal
Course out comes: CO	On completion of this course, the students will be Able to:
CO1	Understand the implications of GLP.
CO2	Learn the working principles of different instruments.
CO3	Gain the knowledge on techniques of histology and his to chemistry.
CO4	Acquire knowledge on the basic principle and application of various modules of light and electron micros copy.

Unit	Contents.	Hrs.
I	Microscopy: Compound (Dark and Light field), Phase Contrast, Fluorescent, Polarized, Electron (Transmission and Scanning), AFM and Confocal Microscope - Micrometry.	12
II	Histology- Sectioning, fixation and staining of tissues. Centrifuge Clinical, Density gradient and Ultra - sedimentation coefficient. GM counter, Liquid Scintillation counter, Lyophilizer, Spectrophotometer (visible, Ultraviolet), ELISA Reader. FTIR, NMR, XRD, Atomic Absorption and Mass Spectrophotometer. Histology- Sectioning, fixation and staining of tissues. Centrifuge Clinical, Density gradient and Ultra - sedimentation coefficient. GM counter, Liquid Scintillation counter, Lyophilizer, Spectrophotometer (visible, Ultraviolet), ELISA Reader. FTIR, NMR, XRD, Atomic Absorption and Mass Spectrophotometer.	12

III	Chromatography: Paper, Thin layer, Column, gel filtration, ion exchange, Gas and HPLC, PAGE, Agarose Gel Electrophoresis, 2D Gel Electrophoresis, Western blotting, and PCR.	**12**
IV	Identification of research problems - Steps in formulating a research problem. Thesis writing - Introduction, Review of literature, Methodology, Results - illustrations and tables, Discussion, Bibliography	**12**
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.	**12**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
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. Isotopesin Biology, Academic Press, pp-173. 4. Srivastava, B.B. 2005. Fundamentals of Nuclear Physics, Rastogi Publication s, pp-500.

Reference books:	1. Pearse, A.G.1968. Histochemistry: Theoretical and Applied,Vol. I,Third Edition, J & A Churchill Ltd, pp-758. 2. Lillie, R.D.1954. Histopathologic Technic and Practical Histochemistry, Second Edition, Blakiston, New York, pp-715. 37 3. Hoppert, M.2003. Microscopic Techniques in Biotechnology, Wiley-VCH GmbH, Weinheim, Germany, pp-330.
Web Source	1. https://microbenotes.com/types-of-microscopes/ 2. https://webpath.med.utah.edu/HISTHTML/HISTOTCH/HISTOTCH.html 3. www.agilent.com/cs/library/applications/histology-scanning- light20microscopy-5994-3068ENagilent.pdf 4. https://microbenotes.com/types-of-centrifuge/

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Biostatistics

Title of the Course	**Biostatistics**						
Course Type	**Elective - III**						
Year	**I**	**Semester**	**II**	**Credits**	**3**	**Course Code**	**25PEZO21**
Instructional Hours per week		**Lecture**		**Tutorial**	**Lab Practice**	**Total**	
		3		**1**	**-**	**4**	
Learning Objectives							
LO1	Students understand the basic principles, methodology and applications of Widely used instruments in biological sciences.						

Course outcomes: CO	**On completion of this course, the students will be Able to:**
CO1	Clear understanding of design and application of Biostatistics relevant to experimental and population studies.
CO2	Acquired skills to perform various statistical analyses using modern statistical techniques and software.
CO3	Knowledge on the merits and limitation of practical problems in biological/ health management study as well as to propose and implement appropriate Statistical design /methods of analysis.

Unit	Contents	Hrs.
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.	**12**
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.	**12**
III	Probability: Theories and rules; Probability - Addition and multiplication theorem; Probability distribution: Properties and application of Normal, Binomial and Poisson distributions	**12**
IV	Hypothesis testing: Student' t' test - paired sample and mean difference 't' tests. Correlation: Types - Karl Pearsons Co-efficient, Rank correlation, Significance test for correlation coefficients. Regression analysis: Computation of biological data, calculation of regression co-efficient, graphical representation and prediction.	**12**
V	Analysis of variance: one way and two-way classification. Data analysis with comprehensive statistical software using Statistical Package for the Social Sciences (SPSS)	**12**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

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.
Reference books:	1. Arora, P.N. and P.K. Malhan. 1996. Biostatistics, Himalaya Publishing House, Mumbai, pp-447. 2. Gurumani, N.2005.Introduction to Biostatistics, M.J.P. Publishers, Delhi, pp- 407. 3. Das, D. and A. Das. 2004. Academic Statisticsin 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.
Web Source	1. www.lkouniv.ac.in/site/writereaddata/siteContent/202004241216240 370priyamka_SDS_COLLECTION_OF_DATA.pdf 2. https://dspmuranchi.ac.in/pdf/Blog/Classification_and_Tabulation_of_Data 3. www.gacariyalur.ac.in/econtent/zoo/pg/PG-II-Bio-Stat&Comp-Appl.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Poultry Farming

Title of the Course	Poultry Farming						
Course Type	Skill Enhancement Course - I						
Year	I	Semester	II	Credits	3	Course Code	25PSZO21
Instructional Hours per week		Lecture		Tutorial	Lab Practice	Total	
		3		1	-	4	
Learning Objectives							
LO1	Students should know basic concepts in Poultry Farming						
LO2	Student should learn feed preparation and feeding mechanism of poultry animal						
LO3	Student learn how to design and poultry farming						
LO4	Student should learn Handle and management of poultry animal						

Unit	Contents	Hrs.
I	General introduction to poultry arming – Definition of Poultry - Past and present scenario of poultry industry in India - Principles of poultry housing - Poultry houses - Systems of poultry farming	12
II	Management of chicks - growers and layers - Management of Broilers. - Preparation of project report for banking and insurance.	12
III	Poultry feed management-Principles of feeding, Nutrient requirements for different stages of layers and broilers - Feed formulation and Methods of feeding.	12
IV	Poultry diseases-viral, bacterial, fungal and parasitic (two each); symptoms, control and management; Vaccination programme.	12
V	Selection, care and handling of hatching eggs- Egg testing. Methods of hatching. Brooding and rearing -.Sexing of chicks. -Farm and Water Hygiene- Recycling of poultry waste.	12

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts	1. www.asci-india.com/BooksPDF/Small%20Poultry%20Farmer.pdf 2. https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf 3. http://ecoursesonline.iasri.res.in/course/view.php?id335 4. https://swayam.gov.in/nd2_nou19_ag09/preview
Reference books:	1. Sreenivasaiah, P.V., 2015. Textbook of Poultry Science.1st Edition. Write & Print Publications, New Delhi 2. 2. JullA. Morley, 2007. Successful Poultry Management. 2ndEdition. Biotech Books, New Delhi" 3. Hurd M.Louis, 2003. Modern Poultry Farming.1stEdition. International Book Distributing Company, Lucknow." 4. Life and General Insurance Management"
Web Source	1. https://agritech.tnau.ac.in/animal_husbandry/ani_chik_housing.html 2. www.hrmrajgurunagar.ac.in/uploads/student_corner/chap1.pdf 3. https://nios.ac.in/media/documents/nsqf/Poultry_Farming_(653).pdf 4. https://e-planet.co.in/images/Publication/vol-20-1/poultry_farming.pdf

Course outcomes: CO	On completion of this course, the students will be able to:
CO1	To understand the various practices in Poultry farming. To know the needs for Poultry farming and the status of India in global market
CO2	To be able to apply the techniques and practices needed or Poultry farming.
CO3	To know the difficulties in Poultry farming and be able to propose plans against it.

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester - III

Genetics and Evolution

Title of the Course		**Genetics and Evolution**					
Course Type		**Core - V**					
Course Code		**25PMZO31**					
Year	**II**	**Semester**	**III**	**Credits**	**6**		
Instructional Hours Per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		4	**2**		**--**	**6**	
Learning Objectives							
LO1	Explain the different principles of inheritance						
LO2	Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.						
LO3	Apply the concepts and rate of change in gene frequency through natural selection, migration and random genetic drift						
LO4	Comprehend the concepts of variation and adaptation. Evaluate the process of evolution of higher taxa						
Course outcomes	**On completion of this course, students will be able to:**						
CO1	Explain the different principles of inheritance						
CO2	Explicate the structures and functions of chromosomes and identify the diseases caused by the chromosomal abnormalities.						
CO3	Apply the concepts and rate of change in gene frequency through natural selection, migration and random genetic drift						
CO4	Comprehend the concepts of variation and adaptation. Evaluate the process of evolution of higher taxa						
CO5	Explain the different principles of inheritance						

Unit	Contents	Hrs.
I	Mendelian Principles -Monohybrid cross and law of segregation, modification of 3:1 phenotypic ratio – Co dominance, incomplete dominance. Lethality and interaction of genes – Lethality, interactions involving 2 gene pairs, epistatic interactions, interaction involving more than 2 gene pairs, pleiotropy, complementary, supplementary, penetrance and expressivity. Linkage and crossing over-types – mechanism - theories, Genetic and Cytologic Mapping of Chromosomes, Linkage Maps, mapping with molecular markers and mapping using somatic cell hybrids. Polygenic inheritance, heritability and its measurements.	18
II	Human Genetics: The Chromosomes: Structure, composition and organization, special type of chromosomes, B Chromosomes, karyotypes, Barr bodies. Chromosomal aberrations Numerical aberrations – Euploidy & Aneuploidy. Structural aberrations, Inversion, Translocation, Deletion, Duplication. Chromosomal Anomalies: Down syndrome, Turner syndrome, Edward Syndrome, Klinefelter Syndrome. Pedigree analysis. Human genome project, Prenatal diagnostics – Amniocentesis, Chorionic Villus sampling. Genetic Counselling- Concepts of Eugenics & Euthenics. Sex linked, sex limited and sex influenced Characters.	18
III	Theories of organic Evolution - Lamarckism and Darwinism – Mutation Theory, Modern Synthesis. Sources of variation in a population – Population, Gene Pool and Gene Frequency, Variations– sources of variations – Mutations, Transposons, Recombinations, Natural Selection and other Evolutionary forces. Natural Selection, Hardy-Weinberg equilibrium, kinds of natural selection – Stabilizing, Diversifying Migration, random Genetic Drift.	18
IV	Molecular evolution: origin of life, principles of molecular evolution studies Molecular divergence - Molecular tools in phylogeny, molecular clock. Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, classification identification and interpretation of trees. Phylogenetic and biological concept of species. – Speciation Adaptive radiation - Isolating mechanisms - Allopatricity and Sympatricity - Convergent evolution - Sexual selection - Altruism and evolution..	18
V	Origin of Higher Categories Micro evolution, macro evolution, mega evolution and co evolution. Evolution rates, phyletic gradualism and punctuated equilibrium. Geological time scale; Evolution of man Origin and evolution of man, Unique hominine characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin.	18

IV	Molecular evolution: origin of life, principles of molecular evolution studies Molecular divergence - Molecular tools in phylogeny, molecular clock. Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, classification identification and interpretation of trees. Phylogenetic and biological concept of species. – Speciation Adaptive radiation - Isolating mechanisms - Allopatricity and Sympatricity - Convergent evolution - Sexual selection - Altruism and evolution..	18
V	Origin of Higher Categories Micro evolution, macro evolution, mega evolution and co evolution. Evolution rates, phyletic gradualism and punctuated equilibrium. Geological time scale; Evolution of man Origin and evolution of man, Unique hominine characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin.	18

Extended professional component (Is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC-CSIR/GATE/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional competency, Professional communication and Transferrable skill.

Recommended Texts:	
1	Griffiths, A.J.F., H.J. Muller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. 2012. An Introduction to Genetic Analysis. 11th Edition, W. H. Greeman. New York.
2	.2.Snustad, D.P., Simmons, M.J.2015. Principles of Genetics, John Wiley Publications, pp- 7 8 4 .
3	Klug, W.S. and M.R. Cummings, C.A. Spencer. 2005. Concepts of Genetics, Benjamin- Cummings Publishing Company.
4	Harti, D.L. 2002. Essential Genetics, A Genomic Perspective, Jones & Bartlet.
5	Krebs, J.E., E.S. Goldstein, S.T. Kilpatrick. 2018. Lewin's Genes XII, Jones & Bartlet Publisher, pp- 613.

References Books:	
1	Gardner, E. J., M. J. Simmons and D.P. Snustad. 2006. Principles of Genetics. 8th Edition, John Wiley & Sons. INC. New York, pp-740. 35. .
2	Brooker, R.J. 2014.Genetics: Analysisand Principles.5th Edition, McGraw Hill Publsiher, pp-880.
3	Russell, P.J.2005. Genetics:A Molecular Approach (2ndEdition) .Pearson /Benjamin Cummings, San Francisco, pp850.4.https://onlinecourses.swayam2.ac.in/cec21_bt02/preview
4	Bergstrom, C.T. and L.A. Dugatkin. 2012. Evolution, Second MEDIA Edition. W.W.Norton & Company, International Student Edition, pp-756.
5	Jobling, M., E. Hollox, M. Hurles,T. Kivisild and C.T. Tyler Smith. 2014. Human Evolutionary Genetics. Second Edition. Garl and Sciences, London, pp-650.

Web Resources:	
1	https://onlinecourses.swayam2.ac.in/cec21_bt02/preview
2	www.khanacademy.org/science/high-school-biology/molecular
3	https://bio.libretexts.org/Bookshelves/Introductory_and_General_Biology/Genera_Biology_(Boundless)/43%3A_Animal_Reproduction_and_Development/43.03
4	www.ncbi.nlm.nih.gov/pmc/articles/PMC5835147/
5	www.cell.com/trends/cell-biology/fulltext/S0962-8924(21)00148-3/

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Animal Physiology

Title of the Course		Animal Physiology				
Course Type		Core - VI				
Course Code		25PMZO32				
Year	II	Semester	III	Credits	6	
Instructional Hours Per week		Lecture	Tutorial		Lab Practice	Total
		4	2		--	6

Learning Objectives	
LO1	Students acquire the basic knowledge on physiology of different organizing animals and human.
LO2	Understand the functions of different systems such as digestion, excretion, blood circulatory system, respiration and nervous system of animal relating them to Structure and functions of various organs
LO3	To enable a successful performance in Animal Physiology component of CSIR/ UGC NET.

Course outcomes	On completion of this course, students will be able to:
CO1	Understand the functions of different systems of animals
CO2	Learn the anatomy of heart structure and functions, blood composition, regulation
CO3	Know the transport and exchange of gases, neural and chemical regulation of respiration and function of excretory System
CO4	Acquire knowledge on the organization and structure of central and peripheral nervous systems
CO5	Evaluate the role and mechanism of hormones

Unit	Contents	Hrs.
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.	**18**
II	Blood and circulation: Blood corpuscles, hemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, coagglutination, haemostasis. Cardiovascular system: Anatomy of human heart, myogenic heart, Arteries and Veins, ECG – its principle and significance, cardiac cycle, heartasa pump, blood pressure, neural and chemical regulation of heart.	**18**
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.	**18**
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.	**18**
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.	**18**

Extended Professional Component (is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC/ TRB / NET / UGC–CSIR/GATE/TNPSC/others to be solved (To be Discussed during the Tutorial hour)
Skills acquired from this Course.	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts:	
1	Shepherd, G.M.1994. Neurobiology, OUPUSA Publisher, pp-774.
2	ainsworth, F.R.1981. Animal Physiology: Adaptation in function, Addison Wesley a Longman Publishers, pp-669.
3	Gorden, M.S. et al., 1977. Animal Physiology: Principles and Adaptation, New York, Third Edition.
4	A hearn , 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	Text book of Animal Physiology– R. Nagabhushanam, M.S Kodarkarand R.Sarojini..
7	Gayton, A.C. and Hall, J.E., A Textbook of Medical Physiology,9th Edn., Harcourt Brace and Company Asia Pvt. Ltd., W.B. Saunders Company.

References Books:	
1	Prosser C.L.1991, Comparative Animal Physiology. Part A: Environmental and Metabolic Animal Physiology. Wiley Liss Publishers, pp-592
2	Hoar, S.W. 1983, General and Comparative Physiology, Prentice Hall Publication, pp- 928 .
3	Randall, D., W. Burggren, K. French and R. Eckert. 2001, Animal Physiology Mechanisms and Adaptations, New York: W.H. Freeman and Co., pp
4	Nelson K.S. 1997.Animal Physiology: Adaptation and Environment, Cambridge University Press,pp-617
5	General and Comparative Physiology – William S.Hoar.

Web Resources:	
1 2 3	https://swayam.gov.in/nd1_noc20_bt42/preview6. www.classcentral.com/course/swayam-animal-physiology-128947/ https://swayam.gov.in/nd1_noc20_hs33/preview

Course outcomes	On completion of this course, students will be able to:
CO1	Understand the functions of different systems of animals
CO2	Learn the anatomy of heart structure and functions, blood composition, regulation
CO3	Know the transport and exchange of gases, neural and chemical regulation of respiration and function of excretory System
CO4	Acquire knowledge on the organization and structure of central and peripheral nervous systems
CO5	Evaluate the role and mechanism of hormones

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Lab in Genetics and Evolution and Animal Physiology

Title of the Course	**Lab in Genetics and Evolution and Animal Physiology**					
Course Type	**Core - IX – Lab - 3**					
Course Code	**25PMZOL3**					
Year	**II**	**Semester**	**III**	**Credits**	**6**	
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**
		2	**-**		**4**	**6**
Learning Objectives						
LO1	To acquire practical knowledge in the principles of Genetics and Evolution and analyse the physiological processes to translate the theoretical understanding					

Course outcomes: CO	**On completion of this course, the students will be able to**
CO1	Acquire knowledge in proving the laws in genetics
CO2	Understand the genetic traits in man
CO3	Apply the practical methods to verify Hardy Weinberg law.
CO4	Study the evolutionary significance of fossils.
CO5	Learn the process of salivary amylase activity in relation to temperature

Experiments

Genetics

- Probability and Chi – square testing for Mendel's Laws using color beads a) Law of segregation, b)Law of independent assortment
- Demonstration of random genetic drift using beads
- Observation of various genetic traits in human
- Culture of Drosophila–Demonstration
- Preparation of buccal smear to show Barrbodies in squamous epithelial cells.

Charts/Slides/Models

Down's syndrome, Klinefelter's syndrome, Turner's syndrome, Edward syndrome, Drosophila mutants – White eye and vestigial wings, Human Pedigree Chart, Lac operon, Sex-linked inheritance: X – Linked inheritance, Y- linked inheritance, Lytic and lysogenic cycles, Blood groups and Rh factor

Evolution

- Study of natural selection in Mendelian population using beads.
  Calculate Gene frequency and genotype frequency
- Study on Evolutionary significances of any five fossils.
- Study of analogy (wings of animals) and homology (Fore limbs and hind limbs of vertebrates).
- Estimation of gene and geno type frequencies in the light of Hardy-Weinberg Law based on facial traits.
- Adaptive radiation – beaks of various birds
- Prove Hardy Weinberglaw using Single and Double-cointossing method.

Charts/Models/ Slides Geographical isolation, Phylogram, Mimicry and colouration of animals, Connecting Links–Archaeopteryx, Limulus, Peripatus.

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

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Medical Lab Technology

Title of the Course	**Medical Lab Technology**				
Course Type	**Core Industry Module -VII**				
Course Code	**25PMZO33**				
Year	**II**	**Semester**	**III**	**Credits**	**2**
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**
		3	**1**	**-**	**4**

Learning Objectives	
C1	**Students understand the basic principles, methodology and applications of widely used instruments in biological sciences.**

Course out comes: CO	**On completion of this course, the students will be Able to:**
CO1	Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.
CO2	Explain the characteristics of composition of blood and their function
CO3	Evaluate the usage of the various instruments in clinical diagnosis.
CO4	Analyze the Procedures involved in Diagnostic Techniques
CO5	Evaluate the histological parameters of biological samples.

Unit	Contents	Hrs.
I	Scope of medical laboratory technology. Laboratory principles- organisation of clinical Role of medical laboratory technician. Laboratory safety - toxic chemicals and biohazards waste- biosafety level- good laboratory practice -safety measures- cleaning and sterilization methods, hospital and clinic borne infection and personal hygiene and health issue.	12
II	Composition of blood and their function- haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of hemoglobin-erythrocyte sedimentations rate-packed cell volume- Total count of RBC& WBC- Differential count WBC-blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, Absolute Eosinophil count.	12
III	Definition and scope of microbiology- parasites - Entamoeba-Plasmodium- Leishmania and Trypanosome. Computer tomography (CT scan) - Magnetic Resonance imaging - flowcytometry - treadmill test - PET. Physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.	12
IV	Cardiovascular system- Blood pressure - Pulse - regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) - significance - ultra sonography Electroencephalography (EEG). Techniques of sample processing; Throat swab, sputum, blood, urine, stool, pus, CSF,	12
V	Handling and labelling of histology specimens –Tissue processing - processing of histological tissues for paraffin embedding, block Preparation. Microtomes–types of microtome- sectioning, staining - staining methods - vital staining - mounting- problems encountered during section cutting and remedies - Frozen section techniques.	12

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts	29. Manoharan, A, and Sethuraman, 2003. Essential of Clinical Heamatology, Jeypee brothers, New Delhi. 30. Richard, A, McPherson, Mathew, R, Pincus, 2007. Clinical and management by laboratory methods, Elsevier, Philadelphia .Published by Tata McGraw-Hill Education Pvt. Ltd., 31. Ochei.J.,A. Kolhatkar (2000). Medical Laboratory science: Theory and practice, Published by Tata McGraw-Hill Education Pvt. Ltd, First edition.
Reference books:	15. Godker, P.B. and Darshan, P, Godker, 2011. Text book of medical Laboratory Technology, Mumbai. 16. Guytonand Hall, 2000. Text Book of medical Physiology, 10th edition, Elseiner, New Delhi. 17. Mukerjee, K.L, 1999. Medical Laboratory Technology-Vol, I, II III. Tata MC GrawHill, New Delhi. 4. Sood, R, 2009. Medical Laboratory technology, Methods and interpretation
Web Source	1. www.rchsassam.org/importance-and-scope-of-mlt/ 2. https://healthinfo.healthengine.com.au/blood-function-and-composition 3. https://microbenotes.com/blood-components-formation-functions/ 4. https://microbenotes.com/scope-and-applications-of-microbiology/ 5. https://microbenotes.com/microbiology-history-branches-career/

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Applied Microbiology

Title of the Course	**Applied Microbiology**				
Course Type	**Elective - VI**				
Course Code	**25PEZO32**				
Year	**II**	**Semester**	**III**	**Credits**	**2**
Instructional Hours per week	**Lecture**	**Tutorial**	**Lab Practice**	**Total**	
	3	**1**	**-**	**4**	
Learning Objectives					
LO1	Enable the students to understand the classification and physiology of microbes.				
LO2	Provide advanced knowledge, understanding and application of various fields of Microbiology.				
Course outcomes: CO	**On completion of this course, the students will be able to:**				
CO1	Relate the basic understanding on taxonomical classification of microbes.				
CO2	Pursuing high skills and knowledge on bacterial isolation, Sterilization and Preservation				
CO3	Analyse the nutritional requirements, common microbial flora in Food.				
CO4	Evaluate microbiological role in the manufacture of industrial products; solve environmental problems.				
CO5	Impart the knowledge of clinically important human diseases with respect to their causative agent.				

Unit	Contents	Hrs.
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. Mycoplasma and PPLO, Recent trends in microbial taxonomy.	**12**
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.	**12**
III	Food Microbiology Normal microbial flora of common food – food infection – food poisoning – food preservation – microbiology of milk and milk products – Detection of food borne pathogens–food sanitation–food control agencies– Food spoilage–ISI and BIS regulations for packaged drinking water.	**12**
IV	Industrial Applications of Microbial Enzymes – Bioreactors and Types – Biopolymers – Bio surfactants – Bio fertilizers, Bioleaching of metals - Biodegradation using microbial communities -Xenobiotics and Heavy metals degradation in soil – Sewage sludge treatment and utilization.	**12**
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.	**12**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

Recommended Texts	• Prescott LM, JP Harley and DAK lein (2005). Microbiology. Sixth edition, international edition, McGraw Hill. • Stanier R, Ingraham J, Wheelis M and Painter P (2014) General Microbiology. 5th Edition, Macmillan Press. • Kathleen Park Talaro and Barry Chess Foundations in Microbiology 10th Edition. 2018. McGraw Hill Education Publishers, USA. • Gerard J.Tortora, Berdell R.Funke, Christine L. Case, Microbiology: An Introduction, 12th Edition (2017) Pearson publishers, USA
Reference books:	• Dubey RC and Maheswari DK (2012).A Text of Microbiology (Revised edition). S. Chand and Company Ltd., New Delhi. • Pelczar TRMJ Chan ECS and Kreig NR (2006).Microbiology. Fifth edition, Tata McGraw-Hill INC. New York. • Geeta Sumbali and Mehrotra RS (2009). Principles of Microbiology. First edition, Tata McGraw Hill P. Ltd., New Delhi.
Web Source	1. https://mis.alagappauniversity.ac.in/siteAdmin/dde-admin/uploads/2/PG_M.Sc._Zoology_350%2023 2. https://archive.nptel.ac.in/content/storage2/courses/102103015/module1/lec 1/2.html 3. https://tau.edu.ng/assets/media/docs/history-development-and-scope-of- microbiology-mcb-102_1720090111.pdf 4. https://microbenotes.com/five-kingdom-system-of-classification-features- and-limitations/

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Dairy Farming

Title of the Course	**Dairy Farming**					
Course Type	**Skill Enhancement Course - II**					
Course Code	**25PSZO31**					
Year	**II**	**Semester**	**III**		**Credits**	**2**
Instructional Hours per week		**Lecture**	**Tutorial**	**Lab Practice**	**Total**	
		3	**1**	**-**	**4**	

Learning Objectives	
LO1	To create awareness on economic importance of Dairy farming

Course outcomes: CO	**On completion of this course, the students will be Able to:**
CO1	To understand the various practices in Dairy farming. To know the needs for Dairy farming and the status of India in global market.
CO2	To be able to apply the techniques and practices needed for Dairy farming.
CO3	To gain knowledge on feed additives and to apply it in feed management in Dairy farming.
CO4	Understand about Milk and its products. To apply Different techniques to protect milk products from getting spoiled.
CO5	Explain the methods to protect cattle from diseases and the medicines to be given if they are infected

Unit	Contents	Hrs.
I	Introduction to Dairy Farming- Advantages of dairying- Classification of breeds of cattle. Indigenous and exotic breeds- Selection of dairy cattle. Breeding-artificial insemination Dairy cattle management-General Anatomy.	12
II	Construction of Model Dairy House - Types of Housing - Different Managemental Parameters - Winter Management - Summer Management – Cleaning & Sanitation.	12
III	Feedstuffs available for livestock-Roughages-Concentrates- Energy rich concentrates - Protein rich concentrates - Mineral Supplements- Vitamin Supplements- Feed additives –Feeding management- Calves Feeding- Feeding of adults-Feeding of pregnant dairy animals - Feeding pregnant heifer.	12
IV	Milk-Composition of milk-milk spoilage-pasteurization - Role of milk and milk products in human nutrition – Dairying as a source of additional income and employment.	12
V	Contagious disease - Common Bacterial (Anthrax, and Mastitis)fungal (Dermatophytosis, Mycotic)- Protozoal (Coccidiosis, Cryptosporidiosis)– Helminth (Gastrointestinal nematodes, Liver flukes, Liver flukes, Tapeworms) and Viral Diseases (Foot-and-Mouth Disease, Bovine Viral Diarrhea (BVD), Infectious Bovine Rhinotracheitis (IBR)- Parasitic Infestation –Deworming, Dehorning, Vaccination -Biosecurity.	12

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. https://agritech.tnau.ac.in/farm_enterprises/Farm%20enterprises_%20Dair y%20unit.html 2. https://www.google.co.in/search?tbo=p&tbm=bks&q=inauthor:%22Tata, +S.N.,+ed%22 3. James. N. Marner, 1975. Principles of dairy processing, wileyeastern limited, New Delhi. 4. Baradach, JE. Ryther. JH.and, MClarney WO., 1972. Aquaculture.The farming and Husbandry of Fresh water and Marine Organisms. Wiley Inter Science, New York.

Reference books:	• The Veterinary Books for Dairy Farmers by Roger W. Blowey. • Hand Book of Dairy Farming by Board Eiri. • Hand book of animal husbandry TATA, S.Ned., ICAR 1990 • Prabakaran, R.1998. Commercial Chicken production. Published by P. Saranya, Chennai. • Hafez, E.S.E., 1962. Reproduction in Farm Animals, Lea & Fabiger Publisher.
Web Source	1. https://ncert.nic.in/vocational/pdf/kedf101.pdf 2. www.agritech.tnau.ac.in/animal_husbandry/animhus_cattle.html 3. www.agritech.tnau.ac.in/expert_system/cattlebuffalo/Housing%20M 4. https://ccari.icar.gov.in/dss/cow.html 5. https://shuats.edu.in/syllabus/IDDDH.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PSO1	PSO 2	PSO 3	PSO4	PSO5
CO1	2	3	2	3	3	3	2	3	2	2
CO2	2	3	3	3	2	3	2	3	3	3
CO3	2	3	3	3	3	3	3	3	3	2
CO4	2	3	3	3	2	2	3	2	2	2
CO5	3	3	3	2	3	2	3	3	3	3

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Semester - IV
Immunology

Title of the Course		Immunology					
Course Type		Core - XI					
Year	II	Semester	IV	Credits	6	Course Code	25PMZO41
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		4	2		--	6	

Learning Objectives	
LO1	To comprehend the fundamentals of immunology and its importance in human health and disease..
LO2	To identify the different types of immune cells and their functions.
LO3	To enable the students to find out the immune response system and its importance.
LO4	To know the antigen–antibody interaction and auto immune disorders.

Course outcomes	On completion of this course, students will be able to:
CO1	Various basic concepts in immunology and organization of immune systems.
CO2	Understanding immunogenicity, vaccines
CO3	Mechanisms of immune response in health and their defects in various diseases.
CO4	The application of immunological principles in biomedical sciences including blood transfusion, tissue grafting and organ transplantation.
CO5	Vaccinology and its importance in disease management

Unit	Contents	Hrs.
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	18
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.	18
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	18
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	18
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; Immuno -deficiency diseases: types including SCID and consequences; Viral (HIV), bacterial (tuberculosis) and parasitic (malaria) diseases: etiology, host immune responses and evasion Bypathogens; Tumour immunology, transplantation immunology.	18

Extended professional component (is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC /TRB/NET/UGC-CSIR/GATE/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional competency, Professional communication and Transferrable skill.

Recommended Texts:	
1	Weir, D. M and J. Stewart. . Immunology, Churchill Livingstone, London, pp-362
2	Janeway, C. A andP.Travers.1997. Immunology, Garland Publ. Inc., London, pp-904
3	Peakman, M and D.Vergani.1997. Basic and Clinical Immunology, Churchill Livingstone, London,pp366
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.
References Books:	
1	Kuby, J.1997. Immunology. W.H. Freeman &Co., New York, pp-670.
2	Male, D.J. Brost off, D.B. Rothand 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 Black well, UK, pp-406.

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Ecology

Title of the Course		Ecology					
Course Type		Core - VII					
Year	II	Semester	IV	Credits	6	Course Code	25PMZO42
Instructional Hours per week		Lecture	Tutorial		Lab Practice	Total	
		4	2		--	6	

Learning Objectives	
LO1	Knowing the ecology and climatic changes at world level and its impact on natural resources.
LO2	Understanding the contributing factors for pollution in the environment and the ways in controlling and restoring to natural conditions.
LO3	Analyse the Eco system and energy flow.
LO4	To know the Abiotic-Biotic interaction.

Course outcomes	On completion of this course, students will be able to:
CO1	Learn about the ecosystem, biotic communities and utilizing the energy processing.
CO2	Study the various community and population and population control
CO3	Understand species interaction and ecological succession.
CO4	Analyse the different types of ecosystems and their energy flow
CO5	Realizing the nature of pollution and the ways for its control / reduction. Impact to environmental studies on solid waste management

Unit	Contents	Hrs.
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.	18
II	Population ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of meta population-demes and dispersal, inter demi extinctions, age structured populations-action taken to control population explosion.	18
III	Species interactions: Types of interactions, interspecific competition, herb ivory, carnivory, pollination, symbiosis. Community ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and Eco tones. Ecological succession: Types; mechanisms; Changes involved in succession; concept of climax.	18
IV	Ecosystem: Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine). Biogeography: Major terrestrial biomes; theory 0of island Bio geography; bio geographical zones of India.	18
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).	18

Extended professional component (is a part of internal component only, not to be included in the external examination question paper).	Questions related to the above topics, from various competitive examinations UPSC /TRB/NET/UGC-CSIR/GATE/TNPSC others to be solved (To be discussed during the Tutorial hours)
Skills acquired from this course	Knowledge, Problem Solving, Analytical ability, Professional competency, Professional communication and Transferrable skill.

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.
References Books:	
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, Mc Graw Hill Boston, 5th Edition.
5	Online courses.nptel.ac.in / noc19 -ge23/preview
6	Classcentral.com/course/swayam-ecology-and environment– 14021.Male, D.J. Brost off, D. B. RothandI. Roitt.2006.Immunology(7thedition), Mosby/Elsevier, Philadelphia, pp-472

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Lab course in Immunology and Ecology

Title of the Course	**Lab course in Immunology and Ecology**						
Course Type	**Core - XIII**						
Year	**II**	**Semester**	**IV**	**Credits**	**3**	**Course Code**	**25PMZOL4**
Instructional Hours per week		**Lecture**		**Tutorial**		**Lab Practice**	**Total**
		2		**-**		**2**	**4**
Learning Objectives							
LO1	To provide hands on training to perform specific lab courses in immunology and ecology.						

Course out comes CO	**On completion of this course, the students will be able to**
CO1	Acquire knowledge in proving the laws in genetics
CO2	Understand the genetic traits in man
CO3	Apply the practical methods to verify Hardy Weinberg law.
CO4	Study the evolutionary significance of fossils.
CO5	Learn the process of salivary amylase activity in relation to temperature

Experiments

Immunology

- Identification of Lymphoid organs in rat / chick – dissections.
- Identification of various types of immune cells in peripheral blood smear.
- Observation of WBCs.
- Single radial immune diffusion technique
- Double immune diffusion
- Agglutination titer–Determination of agglutination titer

Spotters/Charts/Models

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

Ecology

- Measurement of primary productivity in relation to biomass.
- Estimation of dissolved O2 and Carbondioxide in the given water samples.
- Estimation of salinity and total alkalinity
- Identification of fresh water/Marine planktons
- Estimation of pH indifferent water samples
- Visit and field study report on a pond/ forest /marine ecosystem (anyone). Spotters/ Charts / Models Commensalism, Mutualism, Parasitism, food web, Inter specific and Intra specific competitions, Ecological Pyramid of number, Biomass and energy.

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Aquaculture

Title of the Course	**Aquaculture**						
Course Type	**Elective - VI**						
Year	**II**	**Semester**	**IV**	**Credits**	**3**	**Course Code**	**25PEZO41**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	**1**		**-**	**4**	
Learning Objectives							
LO1	Students should know basic concepts in Aquaculture.						

Course outcomes: CO	**On completion of this course, the students will be able to:**
CO1	To develop knowledge on the fish farm and their maintenance.
CO2	Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques.
CO3	To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval culture.
CO4	Identify the different fish's diseases, diagnosis and their management strategies.
CO5	Understand the biology of freshwater and marine Ornamental fishes and activities of central aquaculture organizations.

Unit	**Contents**	**Hrs.**
I	Importance of aquaculture- Present status, prospects and scope in India. Freshwater aquaculture- Brackish water aquaculture- Mari culture – 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, O2, pH).Control of parasites, predators and weeds in culture ponds. Fish farm implements- Secchidisc- aerator- pH meter -feeding trays–Fishing gears used in aqua farming.	**12**

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.	**12**
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) –Fish harvesting, processing and marketing. Brackish water fish culture. Edible and pearl oyster culture, Crab culture. Economic importance of Lobster, Sea urchin and Sea cucumber. Types of Seaweeds- species and methods of culture – by-products	**12**
IV	Fish and Shrimp diseases and health management – infectious diseases – Bacterial: Dropsy, Erythroderma – Fungal: Branch iomycosis (Gill rot), Aspergillo mycosis – Viral: Epizoatic Ulcerative Syndrome, Viral Hemorrhagic Septicaemia (VHS) – Protozoan: Ichthyopthiriasis (White Spot Disease), Myxozoans (Whirling Disease); Non-infectious- environmental and nutritional diseases diagnosis, prevention and control measures.	**12**
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.	**12**

Extended Professional Component (is a part of internal component only, Not to be included in the External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC/CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill

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 ofIndia, VoL Iand Vol. II. WilliamSawson and Sons Ltd., London. 3. Jhingran,V.G.(1991).FishandFisheriesofIndia.Hindustan Publishing Co., India 4. Maheswari.K. (1983) Common fish disease and their control. Institute of Fisheries Education, Powarkads (M.P).
Reference books:	1. Pillay, T.V.R. (1990) .Aquaculture: Principlesand Practices. Blackwell Scientific Publications Ltd. 2. Santhanam, R. (1990).Fisheries Science. Daya PublishingHouse. 3. Sinha, V.R.P.and Srinivastava, H.C. (1991).Aquaculture Productivity. Oxford and IBH Publications CO., Ltd., New Delhi. 4. Yadav, B.N. (1997).Fish and fisheries. Daya Publishing house,NewDelhi.
Web Source	1. www.agriindiatoday.in/Volume%2003-Issue2004-https://krishi.icar.gov.in/jspui/bitstream/123456789/20211/1/2018%20June 2. https://course.cutm.ac.in/wp-content/uploads/2020/06/Unit-5-Site-selection-and-construction-of-fish-farm-1.pdf

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Forensic Science

Title of the Course	**Forensic Science**						
Course Type	**Skill Enhancement Course - III**						
Year	**II**	**Semester**	**IV**	**Credits**	**3**	**Course Code**	**25PSZO41**
Instructional Hours per week		**Lecture**	**Tutorial**		**Lab Practice**	**Total**	
		3	**1**		**-**	**4**	
Learning Objectives							
LO1	To understand the different aspects of Forensic Biology and some very specific areas such as DNA forensics, Wild Life Forensics and Forensic Entomology.						
LO2	To learn in details, the Forensic Examination of body fluids, and Hair and its significance.						

Course outcomes: CO	**On completion of this course, the students will be able to:**
CO1	To develop knowledge on the fish farm and their maintenance.
CO2	Understand the methods of fish seed and feed production and develops knowledge on hatchery techniques
CO3	To apply the knowledge about different culture methods in aquaculture and gain knowledge on fish and shrimp breeding techniques and larval culture.
CO4	Identify the different fish's diseases, diagnosis and their management strategies.
CO5	Understand the biology of freshwater and marine Ornamental fishes and activities of central aquaculture organizations

Unit	Contents
I	Introduction to Forensic Science Forensic Science-definition, history, development and scope. Concepts, functions and need of forensic science. Principles and Methods of Forensic Science. State and Central Forensic Science Laboratories. Mobile Forensic Science Laboratory. Locard's Exchange Principle.
II	Forensic Importance of Body fluids and evidence Common body fluids. Collection and preservation of blood evidence. Distinction between human and non-human blood. Forensic characterization of bloodstains. Typing of dried stains. Semen. Forensic significance of semen. Collection, evaluation and tests for identification of semen. Composition, functions and forensic significance of saliva, sweat, milk and urine. Nature and importance of biological evidence. Significance of hair evidence. Transfer and recovery of hair evidence. Comparison of human and animal hair.
III	DNA Forensics and Finger printing: DNA Forensics: DNA as biological blueprint of life. DNA testing in disputed paternity, Application and Forensic Significance of DNA Profiling. Finger printing: Biological basis of fingerprints. Formation of ridges. Fundamental principles of fingerprinting. Types of fingerprints. Fingerprint patterns.
IV	Fundamentals of Forensic Medicine and Toxicology Forensic Medicine-Definition, nature and scope. Inquests. Medico Legal documents. Evidences-Dying declarations-Identification of dead and living persons. Medico-legal autopsy and its importance. Toxicology: Significance of toxicological findings. Techniques used in toxicology. Toxic logical analysis and chemical intoxication tests. Postmortem Toxicology. Human performance toxicology.
V	Wildlife Forensics and Forensic Entomology Wildlife Forensics: Fundamentals of wildlife forensic. Significance of wildlife forensic. Forensic Entomology: Basics of forensic entomology. Insects of forensic importance. Collection of entomological evidence during death investigations.

Extended Professional Component (is a part of internal component only, Not to be included in th External Examination question paper)	Questions related to the above topics, from various competitive examinations UPSC/TRB/NET/UGC–CSIR/GATE/TNPSC/others to be solved (To be discussed during the Tutorial hour)
Skills acquired from this Course	Knowledge, Problem Solving, Analytical ability, Professional Competency, Professional Communication and Transferrable Skill
Recommended Texts	1. Narayana Reddy (1981). Introduction to Forensic Medicine and Toxicology. Calcutta. 2. William G. ckert. , (1997) Introduction to Forensic Sciences, CRC press NewYork.
Reference books:	1. Houck, M. M & Siegel, J. A 2006. Fundamentals of Forensic Science Acadamic Press, London. James, S. H and Nord by, J. J. 2003. 2. Forensic Science- An Introduction to Scientific and Investigative Techniques. CRC Press, USA. Saferstein 2007. An Introduction of Forensic Science Prentice Hall Inc, USA. 3. BasuR.2019.Fundamentalsofforensicmedicineandt oxicology.Books& allied (P) LTD.-Kolkata.
Web Source	1. https://science.howstuffworks.com/locards-exchange-principle.htm 2. https://pmc.ncbi.nlm.nih.gov/articles/PMC8617621/#:~:text=Body%20fluid 3. https://pubs.rsc.org/en/content/articlelanding/2012/an/c1an15200a

Mapping with Programme Outcomes and Programme Specific Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	3	3	2	3	3	2	3	3
CO2	2	3	3	3	2	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	3	3	3	3	3	3
CO5	3	2	3	3	2	3	3	2

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

CO/PSO	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	3	3	3	3	3
CO2	3	3	3	3	3
CO3	3	3	3	3	3
CO4	3	3	3	3	3
CO5	3	3	3	3	3

Blue Print – End Semester Examinations Semester – I to IV

Class: P.G. **Time: 3 Hours** **Max. Marks: 75**

Section A **(10 x 1 = 10)**

Answer all questions.
Choose the correct answer. (With four options)

	Unit I	Unit II	Unit III	Unit IV	Unit V
Question Nos.	1 & 2	3 & 4	5 & 6	7 & 8	9 & 10

Section B **(5 x 5 = 25)**

Answer all questions choosing either (a) or (b).
Answer should not exceed 250 words

	Unit I	Unit II	Unit III	Unit IV	Unit V
Question Nos.	11 (a) & 11 (b)	12 (a) & 12 (b)	13 (a) & 13 (b)	14 (a) & 14 (b)	15 (a) & 15 (b)

Section C **(5 x 8 = 40)**

Answer all questions choosing either (a) or (b).
Answer should not exceed 500 words

	Unit I	Unit II	Unit III	Unit IV	Unit V
Question Nos.	16 (a) & 16 (b)	17 (a) & 17 (b)	18 (a) & 18 (b)	19 (a) & 19 (b)	20 (a) & 20 (b)