பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

NAAC "A++" Grade - State University – NIRF Rank 73, ARIIA- 10

M.Sc. ZOOLOGY PROGRAMME

[Choice Based Credit System (CBCS)

(For those admitted in the academic year 2026-2027onwards) OBE REGULATIONS AND SYLLABUS

(With effect from the academic year 2026-2027onwards)

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- **Preamble**

Zoology is central to our understanding of the world. Zoologists seek to discover the fundamental principles that pinpoint animal life focusing on the diversity, function and evolution of animals and thus providing the scientific basis for our knowledge regarding the life style, physiology, diseases and their curative measure in the natural environment by conducting research in insects to mammalian cells.

- **General Graduate Attributes**

By studying this programme students get state of the art knowledge about the Zoology and also the opportunities available by studying this course. Student get the aptitude for most of the job oriented course opportunities as well as ability to get success in various competitive exams such as TNPSC, UPSC and Indian forest service etc.

- **Programme Specific Qualification Attributes**

By studying this programme the students get the eligibility and capability to clear SET and CSIR NET in Zoology and get eligibility to become Assistant Professors in Zoology as well as NET qualified research scholars. The students also become entrepreneurs and develop their own business and give employment to others.

- **Knowledge and understanding level (K1 and K2)**

This course imparts knowledge which will be helpful to clear the competitive examinations in the field of Zoology. Students can understand the nature, physiology, biochemical and evolutionary aspects of all animals.

- **Application level (K3)**

On completion of this course students can start the clinical and diagnostic labs in the field of biomedicine. They will also be capable of opening sericulture, apiculture and aquaculture industries.

- **Analytical level (K4)**

Students can analyze each and every aspects of pathophysiology and biochemical reaction in animals including human being.

- **Evaluation capability level (K5)**

Students can evaluate environmental conditions, animal metabolism, and human pathological conditions.

- **Scientific or synthesis level (K6)**

By studying this course they can develop new drugs and patenting skills. They can also develop new hybrids using genetic engineering.

- **Vision**

This Department strives to create a suitable an environment that enables teaching and research to attain high levels of excellence (through Publications and Patents) and in which its members can achieve

their full potential right from Molecular Cell Physiology to understanding and targeting diseases like cancer and vector borne diseases, impact of climate change on insect diversity and bat behavior, Cultivation to commercialization of earthworms etc. In addition to the routine work, the Faculties actively engaging in research and also have collaboration with other Universities/ Research Institutions at national as well as International level. So far the Department of Zoology received more than a Crore of Rupees as research grant from various funding agencies like DST, UGC etc.

- **Programme Objectives and Outcomes**

  Spelt the PEOs (Programme Educational Objectives), Programme Specific Objectives (PSOs) and Programme Outcomes (POs)Programme Educational Objectives(PEO)

- To train our stakeholders to transform their theoretical knowledge into practical for the benefit of our society.

Programme Specific Objectives(PSO)

- To motivate our stake holders to adopt fundamental mathematical tools (statistics) and physical Principles (physics, chemistry) to the analysis of relevant biological situations.
- The outgoing students must be talented to identify the major groups of organisms (invertebrates and chordates) with an emphasis on animals and be able to classify them within a phylogenetic framework (Evolution).
- Students will be able to compare and contrast the characteristics of animals that differentiate them from other forms of life (Comparative Biology).
- Our Stake holders would be clever to explain how organisms function at the level of the gene, genome, cell, tissue (Genetics, Cell Biology, Molecular Biology), organ and organ-system. Drawing upon this knowledge, they will be able to give specific examples of the physiological adaptations, development, reproduction and behaviour of different forms of animals.
- To develop our students to apply their scientific knowledge to formulate testable hypotheses, gathering data that spell out these hypotheses, and analyzing those data to assess the degree to which their scientific work supports their society.

Programme Outcomes

PO No.	Programme Outcome	Description
PO1	Disciplinary Knowledge	Demonstrate advanced and systematic understanding of core zoological concepts including animal taxonomy, physiology, evolution, ecology, developmental biology, genetics, and biochemistry.
PO2	Analytical & Critical Thinking	Critically analyze scientific literature, interpret experimental data, and evaluate hypotheses related to animal behavior, population dynamics, physiological adaptations, and evolutionary patterns.
PO3	Laboratory & Field Skills	Execute advanced laboratory techniques (histology, microscopy, molecular biology assays, enzymology) and field sampling methods (biodiversity assessment, ecological monitoring, behavioral observation) with precision, safety, and ethical compliance.
PO4	Research Methodology & Communication	Design and conduct original research using appropriate statistical tools, write scientific papers/theses following standard formats, and effectively present findings through oral and poster presentations in academic or professional settings.
PO5	Application of Bioinformatics &	Use bioinformatics software (BLAST, MEGA, R, SPSS) for phylogenetic analysis, sequence alignment, population genetics,

	Computational Tools	biochemistry and ecological modeling to address zoological research questions.
PO6	Environmental Awareness & Conservation Ethics	Assess anthropogenic impacts on biodiversity and ecosystems, apply principles of wildlife conservation, and advocate for sustainable practices based on scientific evidence and ethical reasoning.
PO7	Problem-Solving in Health & Disease Biology	Analyze host-pathogen interactions, zoonotic disease transmission, and physiological disorders in animals using integrative approaches from immunology, parasitology, and toxicology.
PO8	Lifelong Learning & Professional Development	Independently update knowledge through primary literature, attend conferences, engage in peer review, and adapt to emerging techniques in areas like genomics, climate change biology, or aquaculture for career advancement in academia, industry, or government sectors.

- Zoology program offered by Periyar University will mould our students to transform their theoretical knowledge into practical for the benefit of our Society by promoting agriculture and health care products. They will be the best academician cum Academic advisors for other institution. Our stake holders will get an opportunity to serve for our Government as Zoologist at ZSI, Entomologist in ICAR institutes, Aqua-culturist, Sericulture Specialist as an entrepreneur. There is an opportunity for our young minds to serve as conservators, Educators as Teacher, Professors, etc.

- **Candidate's eligibility for admission**

  Candidates who have qualified B.Sc., Zoology / Animal Science / Any other Degree related to Zoology / Life Sciences approved by the Syndicate of Periyar University, Salem.

- **Duration of the programme**

  The duration of the M.Sc. Zoology Course shall be over a period of Two Years from the commencement of the course. A student shall obtain the M.Sc. Degree in Zoology if he/she has registered, undergone and secured the required minimum credits for all the Core and Elective courses and completed the Project Work / Dissertation within the stipulated time.

M.Sc. Zoology Programme Structure-Course work, contact hours, credits and maximum internal and external marks for the students admitted from 2026-2027 onwards

Semester	Course Code	Title of Course Work	Con. Hr /W	Credit	Int. Mar	Ext. Mar	Total Mark
I	**26PZOC01**	Comparative Anatomy and phylogeny of Invertebrates	6	5	25	75	100
	26PZOC02	Comparative Anatomy of Vertebrates	6	5	25	75	100
	26PZOC03	Biochemistry	6	5	25	75	100
	26PZOP01	Lab Course I	4	2	40	60	100
	26PZOE01/ 26PZOE01A	Bio-instrumentation / Systems biology	5	4	25	75	100
	26PZOSEC01	Medical Lab Technology	3	2	25	75	100
			30	**23**			**600**
II	**26PZOC04**	Cell and Molecular Biology	6	5	25	75	100
	26PZOC05	Comparative Animal Physiology and Endocrinology	6	5	25	75	100
	26PZOC06	Genetics	5	4	25	75	100
	26PZOP02	Lab Course-II	4	2	40	60	100
	26PZOE02/ 26PZOE02A	Microbiology/Entomology	5	4	25	75	100
	26PZONME1/ 26PZONME1A	Nutrition for wellbeing/ Human Endocrinology	3	2	25	75	100
	23PZOHR01	Human Rights (Compulsory)	1	1	25	75	100
			30	**23**			**700**
III	**26PZOC07**	Immunology	5	4	25	75	100
	26PZOC08	Biostatistics & Bioinformatics	5	4	25	75	100
	26PZOC09	Developmental Biology	5	4	25	75	100
	26PZOP03	Lab Course III	4	2	40	60	100
	26PZOE03/ 26PZOE03A	Poultry Farming / Sericulture/	5	4	25	75	100
	26PZONME2/ 26PZONME2A	Ornamental fish culture/ Vermiculture	3	2	25	75	100
	26PZOSEC02	Fishery Biology and Aquaculture	3	2	25	75	100
	26PZOIN01	Internship/ Field Survey/ Industrial Activity	-	1		-	
	26PZOMO01	MOOC *	-	-			
			30	**23**			**700**
IV	**26PZOC10**	Evolution	5	4	25	75	100
	26PZOC11	Ecology	5	4	25	75	100
	26PZOP04	Lab course IV	4	2	40	60	100
	26PZOPR01	Project & *viva voce*	8	6	40	60	100
	26PZOE04/ 26PZOE04A	Apiculture/Animal biotechnology	5	4	25	75	100
	26PZOSEC03	Research methodology	3	2	25	75	100
	23PEX01	Extension Activity	-	1			
			30	**23**			**600**
		Total	**120**	**92**	**710**	**1890**	**2600**

*MOOC Credit transfer available but not Mandatory for qualifying M.Sc Zoology Degree (any Four Weeks Course is eligible)

- **M.Sc. Zoology Programme Structure-Course work, contact hours, credits and maximum internal and external marks for the students admitted from 2026-2027 onwards**
- Furthermore, The TANCHE, Govt. of Tamil Nadu, recommends the candidates to select any one from SWAYAM/MOOC platform if they desire. Extra credits will be included in the Academic Bank of Credit (ABC) portal of the candidate.
- **Examinations**

Examinations are conducted in semester pattern. The examination for the Semester I & III will be held in November/December and that for the Semester II and IV will be in the month of April/May in every academic year.

Candidates failing in any subject (both theory and practical) will be permitted to appear for such failed subjects in the same syllabus structure at subsequent examinations within next 5 years. Failing which, the candidate has to complete the course in the present existing syllabus structure.

- **Scheme for Evaluation and Attainment Rubrics**

Evaluation will be done on a continuous basis and will be evaluated four times during the course work. The first evaluation will be in the 7th week, the second in the 11th week, third in the 16th week and the end – semester examination in the 19th week. Evaluation may be by objective type questions, short answers, essays or a combination of these, but the end semester examination is a University theory examination with prescribed question paper pattern.

Attainment Rubrics for Theory Courses

Internal *(Max. Marks - 25)*

S.No.	Approaches	Marks
1	Internal tests (Best two tests out of 3)	10
2	Attendance	5
3	Seminar	5
4	Assignment	5
Total		**25**

External *(Max. Marks - 75)*

Section	Approaches	Mark Pattern	K Level	CO Coverage
A	Objective Type (Answer all questions)	20X1 = 20 (Multiple Choice Questions)		
B	Descriptive Type (100 to 200 words) (Answer any three out of five questions)	3X5 = 15 (Analytical type questions)		
C	Essay Type (500 to 1000 words) (Answer all questions)	5X8 = 40 (Essay type questions)		

Attainment Rubrics for Lab Courses

Internal *(Max. Marks-40)*

S.No.	Approaches	Marks
1	Practical tests (Best two tests out of 3)	20
2	Attendance	10
3	Record	10
Total		40

External ***(Max. Marks - 60)***

Attainment Rubrics for Research **Internal** ***(Max. Marks - 40)***

Section	Approaches	Mark Pattern (Item X marks)	K Level	CO Coverage
A	Major practical	1X20 = 20		
B	Minor practical	1X10 = 10		
C	Spotters	5X4 = 20		
D	Record (Through External and mandatory submission for exam)	05		
E	Viva-voce (Through External)	05		
Total		**60**		

S.No.	Approaches	Marks
1	Manual involvements in experiments	**30**
2	Attendance	**10**
	TOTAL	**40**

Assessment Rubric for PG Project

Criteria	Excellent (3)	Good (2)	Satisfactory (1)	Unsatisfactory (0)
Literature Review	Comprehensive, critical, and well-organized	Good coverage with minor gaps	Basic review with significant gaps	Poor or missing review
Experimental Design	Robust, well-controlled, statistically sound	Good design with minor flaws	Basic design with several flaws	Poor or missing design
Practical Execution	Independent, precise, and reproducible	Mostly independent with minor issues	Requires significant supervision	Unable to execute experiments
Data Analysis	Advanced statistical/bioinformatics analysis, clear interpretation	Good analysis with minor issues	Basic analysis with errors	Poor or missing analysis
Thesis Writing	Excellent structure, clarity, and scientific writing	Good writing with minor errors	Basic writing with multiple errors	Poorly written or incomplete
Presentation	Clear, confident, excellent visual aids	Good presentation with minor issues	Basic presentation with poor delivery	Unable to present
Ethics & Safety	Full compliance, proactive safety awareness	Good compliance with minor lapses	Satisfactory compliance	Violations observed
Mentor Feedback	Outstanding performance	Good performance	Average performance	Below expectations

External ***(Max. Marks - 60)***

S.No.	Approaches	Marks
1	Project Report (Refer Assessment)	**40**
2	Viva voce	**20**
	TOTAL	**60**

- **Grading System for a Degree**

Evaluation of performance of students is based on ten-point scale grading system as given below.

Ten Point Scale			
Grade of Marks	**Grade points**	**Letter Grade**	**Description**
90-100	9.0-10.0	O	**Outstanding**
80-89	8.0-8.9	D+	**Excellent**
75-79	7.5-7.9	D	**Distinction**
70-74	7.0-7.4	A+	**Very Good**
60-69	6.0-6.9	A	**Good**
50-59	5.0-5.9	B	**Average**
00-49	0.0	U	**Re-appear**
ABSENT	0.0	AAA	**ABSENT**

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PERIYAR UNIVERSITY
DEPARTMENT OF ZOOLOGY
Salem-636011, Tamil Nadu
M.Sc. Zoology Course - SEMESTER-I
(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

COMPARATIVE ANATOMY AND PHYLOGENY OF INVERTEBRATES

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

Course Outcomes (COs) for Comparative Anatomy and Phylogeny of Invertebrates

COs	Course Outcome Objectives	K Level
CO1	Explain the principles of animal taxonomy, species concepts, ICZN rules, taxonomic procedures, modern trends in invertebrate phylogeny, origin of metazoans, and phylogenetic relationships.	K2, K4
CO2	Compare acoelomate, pseudocoelomate, and coelomate body plans; and explain locomotion mechanisms (flagellar, ciliary, hydrostatic) in different invertebrate groups.	K2, K4
CO3	Describe patterns of feeding and digestion in lower metazoans; explain filter feeding mechanisms; compare respiratory organs and respiratory pigments across invertebrate phyla.	K2, K4
CO4	Compare excretory organs (nephridia, Malpighian tubules) and mechanisms; compare primitive and advanced nervous systems across invertebrate phyla.	K2, K4
CO5	Identify free-living and parasitic invertebrate larval forms; explain their evolutionary significance. Describe the general characters and affinities of minor phyla (Rotifera, Entoprocta, Phoronida, Ectoprocta).	K1, K2, K4
CO6	Integrate knowledge of invertebrate structure, function, and phylogeny to understand evolutionary adaptations and relationships among major and minor phyla.	K4, K5

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

Pre-requisite knowledge:
Students should know the taxonomical classification of invertebrate animals in relation to their functional morphology.

Unit	Topic Name	Hrs.	K. level
	Unit 1: Principles of Taxonomy and Phylogeny		
1	Principles of Animal taxonomy; Species concept		K1, K2
	International code of zoological nomenclature (ICZN)		K2, K3
	Taxonomic procedures – collection, preservation, identification, classification		K2, K3
	New trends in taxonomy and phylogeny of Invertebrates – molecular taxonomy, DNA barcoding, cladistics		K2, K4
	Unit 2: Organization of Coelom and Locomotion		
2	Organization of coelom – Acoelomates (Platyhelminthes); Pseudocoelomates (Aschelminthes); Coelomates (Annelida, Arthropoda, Mollusca, Echinodermata)		K2, K4
	Locomotion – Flagella and ciliary movement in Protozoa		K2, K4
	Hydrostatic movement in Coelenterata (Cnidarians – Hydra, Jellyfish), Annelida (Earthworm) and Echinodermata (Starfish)		K2, K4
	Unit 3: Nutrition, Digestion, and Respiration		
3	Patterns of feeding and digestion in lower metazoans (Cnidarians – Hydra; Platyhelminthes – Planaria)		K2, K4
	Filter feeding in Polychaeta (annelids – Sabella, Chaetopterus), Mollusca (bivalves – Mytilus, Unio) and Echinodermata (crinoids)		K2, K4
	Organs of respiration – Gills, lungs and trachea in invertebrates		K2, K4
	Respiratory pigments (hemoglobin, hemocyanin, hemerythrin, chlorocruorin); Mechanism of respiration		K2, K4
	Unit 4: Excretion and Nervous System		
4	Organs of excretion – Nephridia (protonephridia in flatworms, metanephridia in annelids) and Malpighian tubules in insects and arachnids		K2, K4
	Mechanisms of excretion – osmoregulation, nitrogenous waste (ammonia, urea, uric acid)		K2, K4
	Primitive nervous system – Coelenterata (nerve net) and Echinodermata (nerve ring)		K2, K4
	Advanced nervous system – Annelida (ventral nerve cord with ganglia), Arthropoda (Insects – brain, subesophageal ganglion, ventral nerve cord) and Mollusca (Cephalopoda – highly developed brain with complex behavior)		K2, K4

	Unit 5: Invertebrate Larvae and Minor Phyla		
5	Larval forms of free-living invertebrates – trochophore (annelids, mollusks), nauplius (crustaceans), bipinnaria (echinoderms), glochidium (bivalves), planula (cnidarians)		K1, K2
	Larval forms of parasites – miracidium, sporocyst, redia, cercaria (trematodes – liver fluke); cysticercus (tapeworm – Taenia)		K1, K2
	Strategies and Evolutionary significance of larval forms – dispersal, reduced competition between adults and larvae, colonization of new habitats, adaptation to different ecological niches		K2, K4
	Minor Phyla – (a) Rotifera (wheel animalcules), (b) Entoprocta, (c) Phoronida (horseshoe worms), (d) Ectoprocta (Bryozoa – moss animals) and their affinities		K2, K4
	TOTAL HOURS	72	

On the successful completion of the course the Learning Outcomes are

1. Understand animal taxonomy principles, ICZN rules, modern trends including molecular taxonomy and cladistics, and the origin of metazoans.

2. Comprehend acoelomate, pseudocoelomate, and coelomate body plans with locomotion mechanisms in various phyla.

3. Grasp feeding and digestion patterns, filter feeding, respiratory organs, and respiratory pigments across phyla.

4. Recognize excretory organs including nephridia and Malpighian tubules, and nervous systems from diffuse to advanced forms.

5. Understand free-living and parasitic larval forms and describe general characters of minor phyla such as Rotifera and Bryozoa.

6. Appreciate integration of knowledge of invertebrate structure, function, and phylogeny for evolutionary adaptations and relationships.

Reference Books

1.	BARNES, R.D. (1982), Invertebrate Zoology, IV Ed, Holt Saunders International Edition.
2.	BARRINGTON, E.J.W. (1979), Invertebrate Structure and Functions, II Ed., ELBS and Nelson.
3.	MOORE, R.C., LOLICKER and FISCHER, A.G. (1952), Invertebrate Paleontology, McGraw Hill Book Co., Inc., New York.
4.	HYMAN, G.H (1967) The invertebrates, Vol. I to VII, McGraw Hill Book Co., Inc., New York.
5.	HIGHNAM, K.C. and HILL, L. (1979). The Comparitive Endocrinology of Invertebrates, ELBS

6. Textbooks

7.	KOTPAL, R.L (2002) Minor Phyla, Rastogi Publication, Meerut New Delhi.
8.	JORDAN, E.L., and VERMA, P.S., (1993). Invertebrate Zoology, 12th Edition. S. Chand and Co. Ltd., New Delhi.
9.	Dhami, P. S., & Dhami, J. K. (1979). *Invertebrate zoology: A textbook for B.Sc. students of Indian universities* (5th ed.). R. Chand & Company.
10.	Iyer, E. K., & Ananthakrishnan, T. N. (2009). *Manual of zoology: Invertebrata* (Vol. 1, Pt. 1). S. Viswanathan Pvt. Ltd
11.	Thangamani, A., & Arumugam, N. (2022). Animal diversity - I (Invertebrata). Saras Publication.

12. Online Resources (Free or Accessible)

13.	**https://oms.bdu.ac.in/ec/content-bucket/23-7-184-9-20241126_093637.pdf**
14.	**https://tnou.ac.in/NAAC/SSR/C1/1.1.5/MZON-11.pdf**
15.	**https://books.google.co.zm/books?id=YLxJETTBCSsC&printsec=frontcover#v=onepage&q&f=false**

PO–CO Correlation Strength Matrix, *Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	2	2	3	1	1	2	**2.0**
CO2	3	2	2	1	1	1	1	2	**1.6**
CO3	3	2	2	1	1	1	1	2	**1.6**
CO4	3	3	2	1	1	1	1	2	**1.8**
CO5	3	2	3	2	1	1	1	2	**1.9**
CO6	3	3	2	2	2	2	1	3	**2.3**
Average	**3.0**	**2.3**	**2.2**	**1.5**	**1.5**	**1.2**	**1.0**	**2.2**	**2.69**

Final Overall Matrix Score = 2.69/3.00 (89.66%)

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DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-I

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

COMPARATIVE ANATOMY OF VERTEBRATES

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

Course Outcomes (COs) for Comparative anatomy of vertebrates

COs	**Course Outcome**	**K Level**
CO1	Explain the origin and evolution of chordates, general characters, classification of Chordata and protochordates, affinities, retrogressive metamorphosis, and characters of Agnatha/Cyclostomata.	**K2, K4**
CO2	Describe the general characters, classification, and evolutionary significance of fishes (especially Dipnoi), amphibians, and reptiles, including skull morphology and origin.	**K2, K4**
CO3	Describe the general characters, classification, flight adaptations, and origin of birds; and the general characters, adaptive radiation, and origin of mammals.	**K2, K4**
CO4	Compare the integumentary system, brain structure, heart structure, and aortic arches across vertebrate classes, and analyze evolutionary trends.	**K4, K5**
CO5	Compare the respiratory system (including pharyngeal modifications), urinogenital system (kidney types), and pelvic girdles across vertebrate classes.	**K2, K4**
CO6	Integrate knowledge of comparative anatomy and phylogeny to understand the evolutionary relationships among chordates and the adaptive significance of anatomical changes.	**K4, K5**

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

Pre-requisite knowledge: Comparative Anatomy and Phylogeny of Vertebrates requires a foundational understanding of basic evolutionary biology, animal taxonomy, and general zoology

Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1:Foundations of Chordate Evolution and Protochordates			
1	Origin & evolution of chordates; General characters of chordates		K1, K2
	Outline classification of the phylum Chordata		K1, K2
	General characters and classification of protochordates up to order level		K2, K4
	Affinities between protochordates, retrogressive metamorphosis		K2, K4
	Agnatha and Cyclostomata: General Characters and Affinities		K2, K4
Unit 2: Lower Vertebrates – Pisces, and Amphibia			
2	Pisces – Super Class Pisces – General characters and outline classification up to classes		K2, K4
	Dipnoi – Unique features and evolutionary significance		K2, K4
	Amphibia – General, special characters and classification of amphibians up to class level; Origin of tetrapod and amphibians		K2, K4
	Parental care of fishes and amphibians		K2, K4
Unit 3: Higher Vertebrates – Reptilia, Aves and Mammalia			
3	Reptiles – General characters and classification up to order level; Arcades and fossae in the Reptilian skull and origin of Reptiles		
	Aves – General and special characters and classification up to order level		K2, K4
	Flight adaptations in birds and origin of birds		K4, K5
	Mammals – General characters and classification up to order level		K2, K4
	Adaptive radiation in mammals reference with limps and origin of mammals		K4, K5
Unit 4: Comparative Study of Integument, Brain, Heart, and Aortic Arches			
4	Integumentary system in vertebrates		K2, K4
	Evolutionary trends in the structure of Brain: Shark, Frog, Pigeon and Rabbit		K4, K5
	Evolutionary trends in the heart: Shark, Frog, Lizard, Pigeon and Rabbit		K4, K5
	Evolutionary trends in the aortic arches: Fish, Frog, Lizard, Pigeon and Rabbit		K4, K5
Unit 5: Comparative Study of Respiratory, Urinogenital Systems, and Pelvic Girdles			
	Evolutionary trends in the respiratory system: Fish, Frog, Lizard, Pigeon and Rabbit with special reference to modifications of the pharynx		K4, K5

5	Evolutionary trends in the Urinogenital system: Pronephros, Mesonephros and Metanephros		K2, K4
	Evolutionary trends in the pelvic girdles		K2, K4
	TOTAL HOURS		

Learning Outcomes are

1. Understand the origin of chordates, classification up to subphyla, protochordate affinities, and retrogressive metamorphosis.
2. Comprehend characters and evolution of fishes, amphibians, and reptiles including skull types.
3. Grasp birds and mammals, flight adaptations in birds, adaptive radiation in mammals, and origin of mammals.
4. Recognize integument, brain structure, heart structure, and aortic arches across vertebrate classes.
5. Understand respiratory system, urinogenital system from pronephros to metanephros, and pelvic girdles.
6. Appreciate integration of comparative anatomy and phylogeny to understand evolutionary relationships and adaptive significance

Reference Books

1.	Vertebrates: Comparative Anatomy, Function, Evolution McGraw Hill Kenneth V. Kardon
2.	Elements of Chordate Anatomy, Tata McGraw Hills Course Books Weichert C.K and William Presch(1970)
3.	Life of Vertebrates J. Z. Young New York Oxford University Press.
4.	Colbert's Evolution of the Vertebrates: A history of the backboned animals through time (5th ed 2001,Wiley - Liss) Edwin H Colbert, Michael
5.	Romer, A.S. 1971. The Vertebrate body, W.B.S. Saunders, Philadelphia,

Textbooks

6.	Chordate Zoology E. L.Jordan P. S. Verm. S.Chand and company, New Delhi
7.	A Textbook of Zoology Parker, T.J and Haswell, W.A. 1962.,Vol.2,Vertebrates, 7th edition Mac Millan Press, London
8.	Chordate Zoology: A Textbook for Indian Universities.Dhami P. S. Publisher R Chand,
9.	A Manual of Zoology. Ekambaranatha Ayyar. (2000). Vol. II S.Viswanathan and Co
10.	Modern Textbook of Zoology: Vertebrates. Kotpal, R.L. (2020) 5th edition RastogiPublication

Online Resources (Free or Accessible)

11.	**https://epgp.inflibnet.ac.in/?utm**
12.	**https://evolution.berkeley.edu/?utm**
13.	**https://www.britannica.com/animal/chordate?utm**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	3	2	3	3	3	2	2	**2.63**
CO2	3	2	2	1	2	2	1	3	**2.00**
CO3	3	2	2	2	1	1	1	2	**1.75**
CO4	3	3	2	2	2	2	2	2	**2.25**
CO5	3	3	2	2	1	1	2	2	**2.00**
CO6	3	3	2	2	2	2	2	3	**2.38**
Average	**3.00**	**2.67**	**2.00**	**2.00**	**1.83**	**1.83**	**1.67**	**2.33**	**2.167**

Final Overall Matrix Score = 2.167 / 3.00 (72.23%)

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-I

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

BIOCHEMISTRY

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

Course Outcomes (COs) for Biochemistry

COs	Course Outcomes	K Level
CO1	Explain the chemical basis of biomolecular structure, enzyme kinetics, and bioenergetics using thermodynamic principles.	**K2, K4**
CO2	Map and compare the complete sequence of major metabolic pathways (glycolysis, TCA cycle, beta-oxidation, urea cycle) including their regulation and ATP yield.	**K4**
CO3	Calculate energy equivalents (ATP, NADPH, $FADH_2$) and redox balance in catabolic and anabolic processes under varying physiological conditions.	**K3, K4**
CO4	Differentiate tissue-specific metabolic roles and predict how hormonal signals integrate carbohydrate, lipid, and protein metabolism.	**K4, K5**
CO5	Diagnose metabolic derangements (e.g., diabetes, ketosis, lactic acidosis, starvation) by interpreting pathway dysregulation.	**K5**
CO6	Design case-based explanations or simple experimental approaches to demonstrate metabolic adaptation during stress (starvation, exercise, high-fat diet).	**K5**

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

Pre-requisite:
Understanding fundamental properties of elements, atoms, molecules, chemical bonds and interactions, structure, composition and basic knowledge on metabolism of biomolecules in living organisms.

Unit	Topic Name	Hrs.	K. level
Unit 1: Chemical Fundamentals of Life			
1	Water, pH, Buffers, bonds and Interactions, colligative properties and Thermodynamics		K1 & K2
	Biomolecules and Structure (Carbohydrate, Amino acids and lipids); metals in biomolecules		K1, K2 &K4
	Enzymes: Kinetics (Michaelis Menten), Inhibition, and Regulation		K3 &K4
Unit 2: Bioenergetics and Carbohydrate Metabolism			
2	Bioenergetics: ATP, Redox reactions, and High-energy bonds		K1 & K2
	Glycolysis: Reactions, Regulation, and Energy yield		K1 & K3
	Gluconeogenesis and Cori Cycle		K4 & K5
	Pentose Phosphate Pathway (PPP): Oxidative and Non-oxidative phases		K3 & K4
Unit 3: Citric Acid Cycle (TCA) and Oxidative Phosphorylation			
3	Pyruvate Dehydrogenase Complex (PDC) and entry into TCA		K2& K4
	TCA Cycle: Reactions, enzymes, intermediates, and regulation		K4& K5
	Electron Transport Chain (ETC): Complexes I–IV		K2& K4
	Chemiosmosis and ATP Synthase (Oxidative Phosphorylation)		K4& K5
Unit 4: Lipid and Amino Acid Metabolism			
4	Beta-Oxidation of Fatty Acids (even & odd chain)		K2& K4
	Ketogenesis and Ketolysis		K2& K3
	Fatty Acid Synthesis (Palmitate) and Regulation		K4& K5
	Amino Acid Catabolism: Urea Cycle and Carbon skeletons; purine and pyrimidine synthesis		K4& K5
Unit 5: Metabolic Integration and Signaling			
5	Hormonal Regulation: Insulin, Glucagon, Adrenaline, Cortisol		K2& K4
	Tissue-Specific Metabolism: Liver, Muscle, Adipose, Brain		K4& K5
	Metabolic Interplay: Glucose-Fatty Acid Cycle (Randle cycle)		K4& K5
	TOTAL HOURS		

1. On the successful completion of the course the Learning Outcomes are

2. Understand the chemical basis of biomolecular structure including water, pH, buffers, and thermodynamic principles.
3. Comprehend enzyme kinetics using Michaelis-Menten parameters and differentiate types of inhibition.
4. Grasp and compare major metabolic pathways such as glycolysis, TCA cycle, ETC, beta-oxidation, and urea cycle with ATP yield.
5. Recognize energy equivalents and redox balance, and understand the role of uncouplers and ETC inhibitors.
6. Appreciate tissue-specific metabolic roles and comprehend hormonal integration during fed and fasting states.
7. Perceive metabolic derangements including diabetes and ketosis, and understand ketone bodies, glucogenic and ketogenic amino acids.

	Reference Books
1.	NelsonD.L.andM.M.Cox2018.**Lehninger'sPrinciplesofBiochemistry**.(6thEdition).W.H.FreemanPublishers,NewYork.
2.	Berg, J. M., J. L. Tymoczko and L. Stryer 2012. **Biochemistry.** 5th Ed., W.H. Freeman& Co., New York
3.	VoetD.andJ.G.Voet2019.**Biochemistry**.(6thEdition).JohnWiley&Sons(Asia) Pvt. Ltd.
4.	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
	Textbooks
5.	**Lippincott Illustrated Reviews**: Biochemistry Author: Denise R. Ferrier, PhD, Publisher: Wolters Kluwer / Lippincott Williams & Wilkins, Latest edition: 9th Edition (2025)
6.	Ambika Shanmugam's **Fundamentals of Biochemistry**. Dr. K. Ramadevi, Madras Medical College, Chennai.
7.	SatyanarayanaU.andU.Chakrapani2020.**Biochemistry**.(3rdEdition).Booksand Allied (P) Ltd. Calcutta
8.	**Biochemistry**, Saras Publication
	Online Resources (Free or Accessible)
9.	Biochemistry Free For All Open-access textbook from Oregon State University with strong undergraduate coverage.
10.	Biochemistry Free & Easy Beginner-friendly resource with videos and simplified explanations.
11.	Chemistry LibreTexts – Biochemistry Large open educational library covering enzymes, metabolism, proteins, and molecular biology.
12.	Khan Academy Biochemistry Resources Very useful for fundamentals, especially metabolism and enzyme kinetics. Mentioned frequently by students preparing for exams.
13.	PubMed Essential database for research papers and recent advances in biochemistry.

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	1	1	1	1	2	2	**1.63**
CO2	3	3	2	2	2	2	2	2	**2.25**
CO3	2	3	3	2	2	1	2	2	**2.13**
CO4	3	2	1	2	3	2	3	2	**2.25**
CO5	2	3	2	3	1	2	3	3	**2.38**
CO6	2	3	3	3	1	2	3	3	**2.50**
Average	**2.50**	**2.67**	**2.00**	**2.17**	**1.67**	**1.67**	**2.50**	**2.33**	**2.125**

Final Overall Matrix Score = 2.125/3.00=70.83%

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-I

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

LAB COURSE I (COMPARATIVE ANATOMY AND PHYLOGENY OF INVERTEBRATES ,COMPARATIVE ANATOMY OF VERTEBRATES& BIOCHEMISTRY)

Core Paper-	**Credits:2**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

On the successful completion of the course, student will be able to:

	Course Outcome	**K Level**
CO1	Identify and classify important invertebrate and vertebrate specimens based on morphological characteristics, and explain their taxonomic features.	**K1, K2**
CO2	Perform dissections of invertebrates (cockroach, earthworm, prawn) and vertebrates (bony fish) to expose and identify digestive, nervous, and appendicular systems.	**K3**
CO3	Analyze and compare anatomical structures and adaptive features across vertebrate groups (skulls, limb skeletons, scales, feathers) to understand evolutionary relationships.	**K4**
CO4	Perform quantitative biochemical estimations (protein, carbohydrate, DNA) using colorimetric methods (Lowry, Bradford, Anthrone, DNS, Diphenylamine) and enzyme assays (amylase).	**K3, K4**
CO5	Perform qualitative analysis of carbohydrates and proteins using specific biochemical tests (Molisch, Benedict's, Biuret, Ninhydrin, etc.) and interpret color reactions.	**K3, K4**
CO6	Demonstrate proficiency in handling laboratory instruments (spectrophotometer, centrifuge, pH meter, micropipettes) and preparing scientific records, diagrams, and reports.	**K3, K5**

MAJOR Full dissection or quantitative biochemistry, Morphological study or qualitative biochemistry and Quick identification with labelled observation

MAJOR PRACTICALS

S.No.	**Practical Title**	**Organism**	**Key Observation Points**	**Evaluation Basis**
1.	**Dissection of Earthworm – Nervous System**	*Pheretima posthuma*	Expose supra-pharyngeal ganglia (brain), circum-pharyngeal connectives, and ventral nerve cord with segmental ganglia.	*Diagram + Labelling + Identification*
2.	**Dissection of Cockroach – Digestive & Nervous Systems**	*Periplaneta americana*	Expose and label: crop, gizzard, hepatic caeca, Malpighian tubules; dissect ventral nerve cord, sub-oesophageal and supra-oesophageal (brain) ganglia.	*Diagram + Labelling + Identification*
3.	**Dissection of Prawn Nervous System**	*Penaeus indicus*	Expose supra-pharyngeal ganglia, circum-pharyngeal connectives, and ventral nerve cord.	*Mounting + Diagram + Identification*
4.	**Dissection of Bony Fish – Digestive System**	*Arius maculatus / Tilapia mossambicus*	Expose and identify digestive organs in both dorsal and ventral views; label oesophagus, stomach, intestine, liver, gall bladder, pyloric caeca.	*Diagram + Labelling + Identification*
5.	**Morphometric measurements for fishes**	Two fishes	15 morphometric and 5 Meristic characters (Minimum)	Diagram + Comparison +
6.	**Quantitative Estimation of Protein**	Biochemistry	Lowry method: Prepare BSA standard curve; measure absorbance at 660 nm; calculate unknown protein concentration from curve. Bradford method: absorbance at 595 nm.	*Calculation + Graph + Result*
7.	**Quantitative Estimation of Total Carbohydrate**	Biochemistry	Anthrone method: Prepare glucose standard curve; measure absorbance at 620 nm. DNS method: absorbance at 540 nm; calculate total sugar concentration.	*Calculation + Graph + Result*

MINOR PRACTICALS

S.No.	**Practical Title**	**Type**	**Points to Study**
1	**Study & Mounting of**	Permanent slide / dry	Dissect and mount mandibles, maxillae, labium, labrum, and hypopharynx; prepare permanent slide showing structural detail of

	Cockroach Mouthparts	mount	biting-chewing, piercing-sucking, sponging, siphoning type. (Cockroach, Grasshopper, Mosquito, Housefly, Butterfly)
2	**Study of Earthworm body Setae**	Specimen / slide	Identify types of setae (S-shaped); note arrangement per segment; relate to locomotion.
3	**Study of Types of Insect Wings**	Dry specimen / chart	Compare wing venation and modification: dragonfly (membranous), cockroach (tegmina + hindwing), Mosquito (scaled), housefly (haltere). Note order-level adaptations.
4	**Study of Types of Fish Scales**	Slide / specimen	Identify and compare Placoid scale (Dogfish), Cycloid scale (bony fish), and Ctenoid scale (bony fish). Note evolutionary significance.
5	**Study of Types of Feathers**	Specimen / chart	Identify contour feather, flight feather (primary/secondary), down feather, and filoplume. Relate structure to function: flight, insulation, display.
6	**Qualitative Analysis of Carbohydrates**	Biochemistry	Perform Benedict's, and Fehling's, and Iodine tests on unknown samples (glucose, fructose, lactose, sucrose, starch). Record colour change, based on color reactions. and inference.
7	**Qualitative Analysis of Lipids (Salkowski's Test)**	Biochemistry	(Salkowski's Test) Study the Colour change and indication.

SPOTTERS (specimens / slides)

S.N	Specimen / Organism	Material Type	Points to Observe
		I.General and Taxonomical importance	
1.	***Amoeba***	Slide (stained)	Pseudopodia, ectoplasm vs endoplasm, nucleus
2.	**Hydra**	Slide (W.M.)	Nematocysts, ectoderm, endoderm, hypostome
3.	**Liver fluke**	Slide (W.M.)	Ocelli (eye spots), auricles, triangular head
4.	***Ascaris lumbricoides (male& female)***	Specimen	Curved posterior end with copulatory spicules, Straight posterior end; vulva near anterior
5.	**Nereis**	Specimen	Parapodia with notopodium and neuropodium, chaetae
6.	***Perna viridis*** **(Green Mussel)**	Specimen	Comb-like ctenidia (gills), byssus threads
7.	**Scorpion**	specimen	White lobulated structures in thorax , Pectines, metasoma, telson with venom gland
8.	**Star fish**	specimen	Shape, morphology and water vascular system
9.	***Ascidia***	Specimen	Shape, morphology and developmemt
10.	***Petromyzon (Lamprey)***	Specimen	Buccal funnel with teeth; 7 pairs of gill openings
11.	Columba	specimen	Shape, morphology, feathers and adaptation
12.	Bat	specimen	Shape, morphology, flying adaptation
		II- Structure and Functions	
13.	***Taenia solium*** **– Scolex**	Slide (W.M.)	Suckers (4) and rostellum with hooks
14.	**Earthworm – Clitellum**	Specimen	Glandular swelling around segments 14–16
15.	**Starfish – Tube feet**	Specimen (aboral view)	Suction cup-like ambulacral structures on underside
16.	**Dogfish – Clasper**	Specimen (male)	Modified pelvic fin; clasper for internal fertilisation
17.	**Trygon sp. (Stingray)**	Specimen	Pectoral fin fusion, whip-like tail with venom spine
18.	**Torpedo sp. (Electric Ray)**	Specimen	Dorso-ventrally flattened; electric organ in pectoral region
19.	**Exocoetus (Flying Fish)**	specimen	Enlarged pectoral fins; gliding adaptation
20.	**Frog – Urostyle**	Skeleton	Fusion of caudal vertebrae; supports pelvic girdle
21.	**Frog - Hyoid apparatus**	Skeleton	Hyoid apparatus
22.	**Skull dog and Rabbit**	Bony skull	Overall Shape, Dentition and diastema between incisors and cheek teeth-
23.	**Pigeon – Synsacrum**	Skeleton	fused vertebral column fusion of multiple vertebrae (thoracic, lumbar, sacral, and caudal) along with the pelvic girdle (ilium, ischium, and pubis)
		III- Larval forms	
24.	**Planula**	Slide (W.M.)	Completely ciliated, solid, no mouth, oval/pear-shaped.

25.	**Muller's larva**	Slide (W.M.)	**8** distinct ciliated lobes around the body.
26.	**Miracidium**	Slide (W.M.)	Ciliated epidermal plates + a distinct black **eye-spot**.
27.	**Trochophore larva**	Slide (W.M.)	Ciliated epidermal plates + a distinct black eye-spot.
28.	**Glochidium larva**	Slide (W.M.)	Top-shaped with two ciliary rings (prototroch & metatroch).
29.	**Nauplius larva**	Slide (W.M.)	Two triangular shell valves with a toothed hinge.
30.	**Bipinaria larva**	Slide (W.M.)	3 pairs of jointed appendages + a median eye.
31.	**Tornaria larva**	Slide (W.M.)	Winding, convoluted ciliary bands (not simple rings).
IV-Phylogeny importance			
32.	**Peripatus**	Specimen	Evolutionary importance
33.	**Limulus**	Specimen	Living fossil
34.	***Amphioxus***	*Whole mount (slide)*	Notochord, myotomes, oral hood, pharyngeal gill slits
35.	**Balanoglossus**	Specimen	Body divided into Proboscis, Collar, and Trunk, **Gill pores** and **greenish hepatic region** on the trunk
V.Biochemistry			
36.	**Centrifuge**	Instrument	Rotor, speed control (RPM), temperature control; balancing principle
37.	**pH Meter**	Instrument	Glass electrode, reference electrode, temperature probe; calibration with buffers
38.	**Colorimeter**	Instrument	Filter selection, cuvette holder, galvanometer; principle of transmitted light
39.	**Ninhydrin**	Chemical	Indicator of Amino acids location chromatography
40.	**Vortex Mixer**	Instrument	Rubber cup, eccentric motor; mixing principle

LO No.	Learning Outcome	Bloom's K Level	Related CO
LO1	Identify and classify invertebrate (Amoeba, Hydra, Liver fluke, Nereis, Perna, Starfish, Scorpion) and vertebrate (Ascidia, Petromyzon, Pigeon, Bat,) specimens based on key morphological features.	**K1, K2**	**CO1**
LO2	Perform full dissections of cockroach (digestive and nervous systems), earthworm (nervous system), prawn (nervous system), and bony fish (digestive system) with proper labelling.	**K3**	**CO2**
LO3	Analyze fish morphometric, scales (placoid, cycloid, ctenoid), feathers (contour, flight, down, filoplume), and adaptive modifications in flying, aquatic, and fossorial vertebrates.	**K4**	**CO3**
LO4	Perform quantitative estimation of protein (Lowry and Bradford methods), total carbohydrate (Anthrone and DNS methods).	**K3, K4**	**CO4**
LO5	Perform qualitative analysis of carbohydrates (Benedict's, Fehling's,) and Lipids (Salkowski's Test). Study the Colour change and indication and interpret color reactions.	**K3, K4**	**CO5**
LO6	Handle laboratory instruments (spectrophotometer, centrifuge, pH meter, colorimeter, water bath, autoclave, micropipettes, cuvettes, vortex mixer) and maintain proper laboratory records, diagrams, and reports.	**K3, K5**	**CO6**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1 (Identification & Classification)	3	2	3	1	1	1	1	2	**1.8**
CO2 (Dissections)	3	2	3	2	1	1	1	2	**1.9**
CO3 (Comparative Anatomy)	3	3	3	2	1	1	1	2	**2.0**
CO4 (Quantitative Biochemistry)	3	3	3	3	2	1	2	2	**2.4**
CO5 (Qualitative Biochemistry)	3	3	3	2	1	1	2	2	**2.1**
CO6 (Instrumentation & Reporting)	2	2	3	3	1	1	1	3	**2.0**
Average	**2.8**	**2.5**	**3.0**	**2.2**	**1.2**	**1.0**	**1.3**	**2.2**	**2.029**

Final Overall Matrix Score = 2.029/3.00=67.63%

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PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-I

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

BIO-INSTRUMENTATION

Elective Paper -	**Credits:3**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

The Course Outcome Objectives of this course to teach the students are

CO No.	**Course Outcome**	**K Level**
CO1	Explain the principles, instrumentation, and applications of various microscopes (light, phase contrast, fluorescence, confocal, TEM, SEM) and sample preparation techniques.	**K2, K4**
CO2	Demonstrate understanding of pH meter calibration, centrifugation principles (RCF, rotor types, differential and density gradient methods), and basic physical methods (sonication, freeze drying).	**K2, K3**
CO3	Apply Beer-Lambert law and differentiate UV-Vis, fluorescence, Raman, and atomic absorption spectrophotometry techniques for biological sample analysis.	**K3, K4**
CO4	Compare and select appropriate chromatography (column, TLC, GC, gel filtration, ion exchange, HPLC) and electrophoresis (agarose, SDS-PAGE, IEF, 2D) techniques for separating biomolecules.	**K4, K5**
CO5	Explain the working principles of biomedical instruments (biosensors, ECG, EEG, MRI, CT, pacemaker, hemodialyzer) and interpret basic outputs (ECG waveforms, EEG patterns, MRI/CT images).	**K2, K4**
CO6	Design a simple experimental protocol combining multiple instruments (e.g., centrifugation + spectrophotometry + chromatography) to isolate and analyze a biomolecule from a biological sample.	**K5**

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

Pre-requisite:
Students should be aware on knowledge of analysis of quantitative and qualitative information by using instruments

Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Microscopy – Principles and Techniques			
1	Principles of microscopy: Resolution, magnification, contrast, and numerical aperture		K1, K2
	Light microscopy, phase contrast microscopy		K2, K4
	Electron microscopy: Transmission (TEM) and Scanning (SEM).		K2, K4
	Sample preparation for EM		K3, K4
Unit 2: pH Meter, Centrifuge			
2	pH meter: Principles, instrumentation, application		K1, K3
	Centrifugation: Principles (types of centrifuges		K2, K4
	Differential and density gradient centrifugation and applications		K4, K5
Unit 3: Spectrophotometry and Molecular Spectroscopy			
3	Principles of spectrophotometry:		K1, K3
	UV and Visible spectrophotometry: Instrumentation (single beam vs. double beam)		K2, K4
	Raman spectroscopy: Principles biological applications		K2, K4
	Atomic absorption spectroscopy (AAS):		K2, K3
Unit 4: Chromatography and Electrophoresis			
4	Principles of chromatography:		K1, K2
	Column and Thin layer chromatography, and applications		K2, K3
	Ion exchange and HPLC chromatography Principles and applications		K4, K5
	Electrophoresis: Principles types –		K4, K5
Unit 5: Biomedical Instruments Techniques			
5	Biosensors:		K2, K4
	Electrocardiogram		K2, K4
	Electroencephalogram (EEG): Principles,		K2, K4
	Magnetic Resonance Imaging (MRI) and Computed Tomography (CT)instrumentation		K2, K4

	Pacemaker: Working principle		K2, K3
	TOTAL HOURS	48	

On the successful completion of the course the Learning Outcomes are

1. Understand principles and applications of light, fluorescence, confocal, TEM, and SEM microscopes.
2. Comprehend Ph meter calibration, centrifugation principles including RCF and rotors, and basic physical methods.
3. Grasp the Beer-Lambert law and differentiate UV-Vis, fluorescence, Raman, and atomic absorption spectrophotometry.
4. Recognize and select chromatography techniques such as HPLC and GC, and electrophoresis methods including SDS-PAGE and IEF.
5. Understand working principles of biomedical instruments like ECG, EEG, MRI, and CT, and interpret basic outputs.
6. Appreciate how to design a simple experimental protocol combining multiple instruments to analyze a biomolecule.

Reference Books

1.	*Principles and Techniques of Biochemistry and Molecular Biology,* Keith Wilson & John M. Walker (Editors), Cambridge University Press
2.	*Biophysical Techniques,* Iain D. Campbell. Oxford University Press.
3.	*Instrumental Methods of Chemical Analysis,* Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House

Textbooks

4.	*A Biologist's Guide to Principles and Techniques of Practical Biochemistry,* Keith Wilson & John Walker,Cambridge University Press.
5.	*Fundamentals of Analytical Chemistry,* Douglas A. Skoog, Donald M. West, F. James Holler, & Stanley R. Crouch,Cengage Learning.
6.	*Principles of Instrumental Analysis,* Douglas A. Skoog, F. James Holler, & Stanley R. Crouch,Cengage Learning.

Online Resources (Free or Accessible)

7.	**MIT OpenCourseWare – Instrumentation & Analytical Techniques** Covers spectroscopy, chromatography, and modern analytical tools with lecture notes and videos.
8.	**Khan Academy – Spectroscopy & Chemistry Tools** **Good for beginners—explains UV, IR, and basic analytical concepts in a simple way.**
9.	https://ocw.mit.edu (Search: Instrumentation in Biology)
10.	**NPTEL Biochemistry & Bioinstrumentation Courses** Indian government platform with structured courses, especially useful for university exams and conceptual clarity.
11.	**https://nptel.ac.in (Search: Bioinstrumentation)**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	3	2	1	1	1	2	**1.875**
CO2	3	3	3	2	1	2	1	2	**2.125**
CO3	3	3	3	3	2	2	2	2	**2.5**
CO4	3	4	3	3	2	1	1	2	**2.375**
CO5	3	3	2	2	2	2	3	3	**2.5**
CO6	2	4	3	3	2	1	2	3	**2.5**
Average	**2.8**	**3.2**	**2.8**	**2.5**	**1.7**	**1.5**	**1.7**	**2.3**	**2.315**

Final Overall Matrix Score = 2.315/3.00=77.16%

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PERIYAR UNIVERSITY

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M.Sc. Zoology Course – SEMESTER-I

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

SYSTEMS BIOLOGY

Elective Paper-	**Credits:3**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

On the successful completion of the course, student will be able to:		
Cos	**Course Outcome**	**K Level**
CO1	Define systems biology, differentiate reductionism from holism, explain emergent properties, and identify components of biological systems.	K2, K4
CO2	Describe different types of biological networks (gene regulatory, protein-protein, metabolic, signaling) and identify simple network properties (nodes, edges, hubs, motifs).	K2, K4
CO3	Explain the basic concepts of genomics, transcriptomics, proteomics, and metabolomics, and describe how they contribute to systems biology.	K2, K4
CO4	Explain the purpose of biological models, compare different types of models, and describe Boolean network models and feedback loops.	K2, K4
CO5	Describe applications of systems biology in human health (diabetes, cancer), drug discovery, personalized medicine, and ecology (food webs).	K2, K4
CO6	Define synthetic biology and discuss ethical considerations in designing new biological systems.	K2, K5

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

Pre-requisite knowledge: This interdisciplinary field that combines molecular biology with following knowledge such as mathematics, computation, programming, statistics and engineering to understand complex biological networks**.**

Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Introduction to Systems Biology			
1	Definition, history and scope of systems biology; why systems biology is needed (limitations of reductionist biology)		K1, K2
	Basic concept of System Apparoach; Reductionism vs. Holism – understanding whole system vs. studying individual parts; examples from daily life		K2, K4
	biological system Appraoch; – components, interactions, and functions; examples (Molecules,cell,tissue,organ, organism, ecosystem)		K1, K2
	Concepts of Model and modelling, Model behaviour and Classification)		K2, K4
Unit 2: Biological Network			
2	biological network – definition; nodes (components) and edges (interactions); simple network diagrams		K1, K2
	Types of biological networks – Gene regulatory networks (genes controlling other genes); Protein-protein interaction networks; Metabolic networks (chemical reactions); Signaling networks (cell communication)		K2, K4
	Simple System network properties – degree (number of connections); hubs (highly connected nodes); why hubs are important		K2, K3
	Systems Network motifs – small recurring patterns (e.g., feed-forward loop); why motifs are important in biology		K2, K4
Unit 3: Omics Technologies – Understanding the Big Picture			
3	Introduction to Omics – definition; why “omics” is important for systems biology		K1, K2
	Genomics – what is genome; whole genome sequencing; what we learn from genome (number of genes, organization)		K1, K2
	Transcriptomics – what is transcriptome; measuring gene expression (RNA-seq, microarrays – basic concept only); how it tells us which genes are active		K2, K4
	Proteomics – what is proteome; how proteins are identified (mass spectrometry – basic concept); protein-protein interactions		K2, K4
	Metabolomics – what is metabolome; small molecules in the cell; how		K2, K4

	metabolomics reflects the cell's state		
Unit 4: Modeling Biological Systems			
4	Need of models in biology – predicting behavior, understanding complex systems, testing hypotheses		K2, K3
	Types of biological models – conceptual models (diagrams, flowcharts); physical models; mathematical models (basic introduction – equations represent relationships); computational models (computer simulations)		K2, K4
	Boolean network models – simple ON/OFF (active/inactive) logic; genes as switches; example – simple genetic switch (lac operon concept)		K2, K4
	Dynamic (Predictive) models – how systems change over time; feedback loops (positive and negative feedback); examples (Game theory of population model, predator-prey cycles)		K2, K4
Unit 5: Applications of Systems Biology			
5	Systems biology in human health – understanding diseases as system disruptions; examples (diabetes – metabolic network disruption; cancer – signaling network disruption)		K2, K4
	Drug discovery and personalized medicine – identifying drug targets using network analysis; why drugs work differently in different people (genetic variation)		K2, K4
	Systems biology in ecology – understanding food webs and ecosystem stability; predicting effects of species removal		K2, K4
	Synthetic biology – designing new biological systems (simple introduction); creating genetic circuits; future possibilities and ethical considerations		K2, K5
	TOTAL HOURS	48	

Learning out comes

1. Understand systems biology, differentiate reductionism from holism, explain emergent properties, and identify biological system components.
2. Comprehend biological networks including gene, protein, and metabolic networks, and identify network properties such as nodes, hubs, and motifs, and draw simple diagrams.
3. Grasp omics technologies including genomics, transcriptomics, proteomics, and metabolomics, and their contribution to systems biology.
4. Recognize the purpose of biological models, compare types including conceptual, mathematical, and computational models, and understand Boolean networks and feedback loops.
5. Understand applications in human health, drug discovery, personalized medicine, and ecology including food webs.
6. Appreciate synthetic biology and discuss ethical considerations in designing new biological systems.

Reference Books

1.	Alon, U. (2019). An introduction to systems biology: Design principles of biological circuits (2nd ed.). Boca Raton, FL: CRC Press.
2.	Klipp, E., Liebermeister, W., Wierling, C., Kowald, A., Herwig, R., & Lehrach, H. (2016). Systems biology: A textbook (2nd ed.). Weinheim, Germany: Wiley-VCH.
3.	Voit, E. O., & Kemp, M. L. (2025). A first course in systems biology (3rd ed.). Boca Raton, FL: CRC Press.
4.	Kitano, H. (Ed.). (2001). Foundations of systems biology. Cambridge, MA: MIT Press.
5.	Palsson, B. Ø. (2015). Systems biology: Constraint-based reconstruction and analysis. Cambridge, United Kingdom: Cambridge University Press.
6.	Joshi, S., Ray, R. R., Nag, M., & Lahiri, D. (Eds.). (2024). Systems biology approaches: Prevention, diagnosis, and understanding mechanisms of complex diseases. Singapore: Springer Nature.

Textbooks

7.	Singh, V., & Dhar, P. K. (Eds.). (2015). Systems and synthetic biology. Dordrecht, Netherlands: Springer.
8.	Raman, K. (2023). An introduction to computational systems biology. Chennai, India: IIT Madras Lecture Notes/Open Text.
9.	Sinha, S., Chatterjee, N., & Jesan, T. (2010). Systems biology: From the cell to the brain. New Delhi, India: Academic Foundation.

Online Resources (Free or Accessible)

10.	**https://epgp.inflibnet.ac.in/?utm**
11.	**https://ramanlab.github.io/SysBioBook/?utm**
12.	**https://www.genome.jp/kegg/?utm**
13.	**https://www.ebi.ac.uk/biomodels/?utm**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	1	1	1	1	1	2	**1.5**
CO2	3	2	1	1	1	1	1	2	**1.5**
CO3	3	2	1	1	2	1	2	2	**1.8**
CO4	3	3	1	2	1	1	1	2	**1.8**
CO5	3	3	1	2	1	2	3	2	**2.1**
CO6	3	3	1	2	1	2	1	3	**2.0**
Average	**3.0**	**2.5**	**1.0**	**1.5**	**1.2**	**1.3**	**1.5**	**2.2**	**1.778**

Final Overall Matrix Score = 1.778/3.00=59.27%

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY
DEPARTMENT OF ZOOLOGY
Salem-636011, Tamil Nadu
M.Sc. Zoology Course - SEMESTER-I

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

MEDICAL LABORATORY TECHNIQUES

Skill Enhancement Course-	**Credits:3**	**Paper Code**
Total Contact Hours:48		**Weekly Contact Hours: 4**

On the successful completion of the course, student will be able to:

Pre-requisite knowledge: A strong foundation in the hematology, biochemical process, safe laboratory practices, and basic computing to handle instruments

COs	Course Outcome	K Level
CO1	Explain bio-safety levels, GLP principles, and biomedical waste management categories.	K2
CO2	Perform basic hematological tests (blood counts, hemoglobin, ESR, PCV, blood grouping) and interpret results.	K3
CO3	Identify common parasites (*Plasmodium*, *Entamoeba*, *Leishmania*) using microscopic examination.	K4
CO4	Differentiate between serological tests (Widal, ELISA) and explain their applications.	K2, K4
CO5	Explain the principles of ECG, EEG, and basic cardiovascular function tests.	K2
CO6	Describe histopathology techniques, clinical biochemistry tests (blood sugar, LFT, RFT, lipid profile), and interpret results.	K2, K4

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

Unit	Topic Name	Hrs.	K. level
Unit 1: BIO-SAFETY AND HEALTH			
1	Issues- Toxic chemicals and biohazards waste		K1, K2
	bio-safety level - good laboratory practice - hygiene and health issue		K1, K2
	Biomedical waste management		K1, K3
Unit 2: BLOOD PROFILE (HEMATOLOGY)			
2	Composition of blood and their function: Collection of blood & lab procedure		K2, K3
	haemopoiesis - types of anaemia - mechanism of blood coagulation - bleeding time - clotting time - determination of haemoglobin - erythrocyte sedimentation rate - packed cell volume		K2, K3
	Total count of RBC & WBC - Differential count WBC - blood grouping and typing		K2, K3
	Haemolytic disease of newborn - Platelet count - haemostasis - bleeding disorder of man reticulocytes count - Absolute Eosinophil count.		K1, K3
Unit 3: PARASITOLOGY- MICROBIOLOGY & IMMUNOLOGY			
3	Definition and scope of microbiology: Parasites – *Entamoeba* – *Plasmodium* - *Leishmania* and *Trypanosome*		K2, K4
	Sputum, Semen, Urine and Stool analyses		K2, K4
	Culturing and identifying bacteria, fungi.		K2, K4
	Serological tests, such as Widal tests and ELISA.		K2, K4
Unit 4: MONITORING OF HEART FUNCTION			
4	Cardiovascular system: Blood pressure - Pulse - regulation of heart rate - cardiac shock - Heart sounds - Electrocardiogram (ECG) - Treadmill test .		K2, K4
	Ultra sonography - Electroencephalography (EEG).		K2, K4
Unit 5: HISTOPATHOLOGY & CLINICAL BIOCHEMISTRY			
5	**HISTOPATHOLOGY:** Handling and labeling of histology specimens: - Tissue processing - processing of histological tissues for paraffin embedding, block preparation, sectioning, staining - staining methods,		K2, K3
	CLINICAL BIOCHEMISTRY: Testing blood sugar, liver function tests (LFT), renal function tests (RFT), and lipid profiles assessment		K2, K4
	TOTAL HOURS	48	

On the successful completion of the course the Learning Outcomes are

1. Understand bio-safety levels from BSL-1 to BSL-4, GLP principles, biohazard handling, and biomedical waste management.

2. Comprehend basic hematological tests including Hb, ESR, PCV, and RBC and WBC counts, and interpret results for anemia and bleeding disorders.

3. Grasp the blood coagulation mechanism, bleeding and clotting time, blood grouping and typing, and related disorders. **4.** Recognize common parasites microscopically, describe sputum, semen, urine, and stool analyses, and differentiate serological tests. **5.** Understand cardiovascular function tests, ECG waves including P, QRS, and T, treadmill test, ultrasonography, and EEG. **6.** Appreciate histopathology techniques, clinical biochemistry tests such as blood sugar, LFT, RFT, and lipid profile, and interpret results.	
Reference Books	
1.	*Handbook of Medical Laboratory Technology,* V.H. Talib,CBS Publishers & Distributors
2.	*Baker & Silverton's Introduction to Medical Laboratory Technology,* F.J. Baker, R.E. Silverton,Butterworth Heinemann
3.	*Medical Laboratory Manual for Tropical Countries* (Volumes I & II)M.,Cheesbrough, ELBS/Butterworths
4.	*Henry's Clinical Diagnosis and Management by Laboratory Methods* R.A. McPherson, M.R. Pincus (Editors),Elsevier
Textbooks	
5.	*Textbook of Medical Laboratory Technology* (Set of 2 Volumes),Darshan P. Godkar & Praful B. Godkar,Bhalani Publishing House
6.	*Textbook of Medical Laboratory Science (Medical Laboratory Technology)* (2Volumes),Multiple Subject Experts (JPB),Jaypee Brothers
7.	*Golden Notes for Medical Laboratory Science,* Ramnik Sood,Jaypee Brothers
8.	*Handbook of Medical Laboratory Technology – A Book for DMLT Students,* Nanda Maheshwari,Jaypee Brothers
Online Resources (Free or Accessible)	
9.	**https://www.cdc.gov/labtraining?utm_source=chatgpt.com**
10.	**WHO Laboratory Quality Management System (LQMS) Training Toolkit Global standard for lab practices:**
11.	**MedlinePlus Medical Test Information Patient-friendly**
12.	**Lab Tests Online (AACC) Run by the American Association for Clinical Chemistry**
13.	**https://www.khanacademy.org/science/health-and-medicine?utm_source=chatgpt.com**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	1	1	2	1	1	2	**1.6**
CO2	3	3	2	2	3	1	2	2	**2.3**
CO3	2	3	2	3	3	1	2	2	**2.3**
CO4	3	3	2	3	3	1	2	2	**2.4**
CO5	3	3	2	3	3	2	2	2	**2.5**
CO6	2	3	1	3	3	2	3	3	**2.5**
Average	**2.7**	**2.8**	**1.7**	**2.5**	**2.8**	**1.3**	**2.0**	**2.2**	**2.257**

Final Overall Matrix Score = 2.257/3.00=85.67%

பெரியார் பல்கலைக்கழகம்

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-II

(T… applicable to the students who are admitted on or after 2026-2027academic year onwards)

CELL AND MOLECULAR BIOLOGY

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

On the successful completion of the course, student will be able to:

COs	**Course Outcome**	**K Level**
CO1	Explain the structure and function of cell organelles, plasma membrane, and endomembrane system.	**K2, K4**
CO2	Describe the cytoskeleton, cell junctions, ECM, and cell adhesion molecules, and their roles in cell physiology.	**K2, K4**
CO3	Analyze cell signaling pathways, cell cycle regulation, and mechanisms of cell death (apoptosis, necrosis, autophagy).	**K4, K5**
CO4	Explain DNA replication mechanisms, telomere biology, and DNA repair pathways.	**K2, K4**
CO5	Describe transcription, post-transcriptional modifications, translation, and post-translational modifications.	**K2, K4**
CO6	Analyze gene regulation mechanisms including Operon concept	**K4, K5**

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

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

Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Cell Biology – Structure and Function of Cell Organelles			
1	Cell theory, evolution of cell types: Prokaryotic vs. Eukaryotic cells		K1, K2
	Plasma membrane: Structure (fluid mosaic model), transport mechanisms		K2, K3
	Nucleus: Nuclear envelope, nuclear pore complex, nucleolus, chromatin organization		K2, K4
	Endomembrane system: ER, Golgi apparatus, lysosomes, structure and functions		K2, K4
	Mitochondria endosymbiotic theory, Structure and function		K2, K4
Unit 2: Cell Biology – Cytoskeleton, Cell Junctions, and Extracellular Matrix			
2	Cytoskeleton: Microfilaments (actin), intermediate filaments, microtubules – structure, dynamics, and associated proteins		K2, K4
	Cell junctions: Tight junctions, adherens junctions, desmosomes, gap junctions, hemidesmosomes		K2, K4
	Extracellular matrix (ECM): Collagen, elastin, fibronectin, laminin, integrins		K2, K4
	Cell adhesion molecules (CAMs): Cadherins, selectins, IgSF – role in development and immunity		K2, K4
Unit 3: Cell Biology – Cell Signaling, Cell Cycle, and Cell Death			
3	Principles of cell signaling: Endocrine, paracrine, autocrine, juxtacrine signaling		K2, K4
	Signal transduction pathways: G protein-coupled receptors (GPCRs), receptor tyrosine kinases (RTKs), JAK-STAT, MAPK/ERK pathway		K4, K5
	Second messengers: cAMP, cGMP, calcium (Ca^{2+}) – synthesis and function		K2, K4
	Cell cycle: Phases (G_1, S, G_2, M), cyclins, CDKs, checkpoint controls		K2, K4
	Cell death: Apoptosis, necrosis, autophagy		K4, K5
Unit 4: Molecular Biology – Central Dogma, DNA Replication, and Repair			
4	Central dogma of molecular biology, reverse transcription, prions.		K1, K2
	DNA structure and types, Double helix, Watson-Crick base pairing, Chargaff rule		K2, K4
	DNA replication in eukaryotes: Initiation, elongation (leading and lagging strands), termination; enzymes		K2, K4
	Telomeres and telomerase: Structure, function, role in aging and cancer		K2, K4
	DNA repair mechanisms: Mismatch repair ,base excision repair ,nucleotide excision repair , homologous recombination,		K4, K5
Unit 5: Molecular Biology – Transcription, Translation, and Gene Regulation			
	Transcription: RNA polymerase I, II, III – promoters, enhancers, silencers, transcription factors (GTFs), Coupled transcription and Translation		K2, K4
	Post-transcriptional modifications: Capping, polyadenylation, splicing alternative		K2, K4

5	splicing, RNA editing		
	Translation: Genetic code, Ribosome structure (rRNA, proteins), tRNA charging, initiation, elongation, termination,		K2, K4
	Post-translational modifications (PTMs): Phosphorylation, glycosylation, ubiquitination, acetylation – functional significance		K2, K4
	Gene Action regulation Operon- *Lac* operon, *Try* Operon		K4, K5
	TOTAL HOURS	**72**	

1. On the successful completion of the course the Learning Outcomes are

2. Understand the structure and function of cell organelles, plasma membrane, nucleus, endomembrane system, and mitochondria.

3. Comprehend cytoskeleton, cell junctions, extracellular matrix, and cell adhesion molecules.

4. Grasp cell signaling pathways, cell cycle regulation involving cyclins, CDKs, and p53, and mechanisms of cell death.

5. Recognize DNA replication in eukaryotes, telomere biology, and DNA repair pathways.

6. Understand transcription, post-transcriptional modifications, translation, and post-translational modifications.

7. Appreciate gene regulation mechanisms such as lac operon and trp operon, and integrate central dogma knowledge.

Reference Books

1.	Lodish, H., Berk, A., Kaiser, C. A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., & Martin, K. C. (2021). **Molecular cell biology** (9th ed.). W. H. Freeman and Company.
2.	De Robertis, E.D.P. and E. M. F. De Robertis Jr, 2017. **Cell and Molecular Biology**. Info-Med, Hong Kong
3.	Karp, G. 2016. **Cell Biology** (8th Edition), John Wiley & Sons, Singapore,
4.	Alberts, B., A. Johnson, J. Lewis, *et al*., 2020, **Molecular Biology of the Cell** (Sixth Edition), Garland Science, New York

Textbooks

5.	Verma, P. S., & Agarwal, V. K. (2016). Cell biology (Cytology, Biomolecules and molecular biology). S. Chand Publishing.
6.	Rastogi, S. C. (2017). Molecular biology (3rd ed.). New Age International.
7.	Paul, A. (2011). Textbook of cell and molecular biology. Books & Allied Ltd
8.	Powar, C. B. (2010). Cell biology (3rd ed.). Himalaya Publishing House. [Details available on Himalaya Publishing House]

Online Resources (Free or Accessible)

9.	**iBiology – Free Video Lectures https://www.ibiology.org**
10.	**Cell Signaling Pathways (Cell Signaling Technology) Interactive Pathways https://www.cellsignal.com/pathways**
11.	**Virtual Cell Animation Collection Interactive Animations https://vcell.nd.edu**
12.	**HHMI BioInteractive Videos & Animations https://www.biointeractive.org**
13.	**https://cellwalk.ca/ An interactive educational platform that allows you to manipulate cellular components and navigate complex molecular pathways visually.**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	2	1	1	1	2	2	**1.8**
CO2	3	2	2	1	1	1	2	2	**1.8**
CO3	3	3	2	2	1	1	3	2	**2.1**
CO4	3	3	2	2	2	1	3	2	**2.3**
CO5	3	3	2	2	2	1	3	2	**2.3**
CO6	3	3	2	2	2	1	3	3	**2.4**
Average	**3.0**	**2.7**	**2.0**	**1.7**	**1.5**	**1.0**	**2.7**	**2.2**	**2.107**

Final Overall Matrix Score = 2.107/3.00=70.23%

பெரியார் பல்கலைக்கழகம்
PERIYAR UNIVERSITY
DEPARTMENT OF ZOOLOGY
Salem-636011, Tamil Nadu
M.Sc. Zoology Course - SEMESTER-II

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

COMPARATIVE ANIMAL PHYSIOLOGY AND ENDOCRINOLOGY

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

On the successful completion of the course, student will be able to:

	Course Outcome	**K Level**
CO1	Explain homeostasis, feedback mechanisms, thermoregulation, osmoregulation, and digestion.	**K2, K4**
CO2	Describe comparative physiology of respiration, blood and circulation, and excretion.	**K2, K4**
CO3	Explain neurophysiology (action potential, synaptic transmission), muscle contraction (sliding filament theory), and sensory mechanisms (vision, hearing).	**K4, K5**
CO4	Describe endocrine glands, hormone classification, hormonal regulation, and cell signaling pathways (cAMP, GPCR).	**K2, K4**
CO5	Explain reproductive physiology, reproductive disorders, ART, neuroendocrine regulation in insects, and behavioural physiology.	**K2, K4**
CO6	Integrate knowledge of multiple physiological systems to explain homeostatic regulation, adaptations, and signal transduction.	**K4, K5**

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

Pre-requisite knowledge: A solid foundation in how biological, chemical, and physical principles have regulated for adapttion to varying environments

Unit.	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Homeostatic Mechanisms, Thermoregulation, Osmoregulation, and Digestive Physiology			
1	Homeostatic Mechanisms – Concept of homeostasis, Feedback mechanisms (positive and negative feedback), Physiological adaptation and acclimatization		K1, K2
	Thermoregulation – Temperature regulation in poikilotherms and homeotherms; Physical, chemical and neural regulation of body temperature; Acclimation and acclimatization; Hibernation, aestivation and diapause		K2, K4
	Osmoregulation – Osmotic and ionic regulation in aquatic and terrestrial animals; Osmoregulation in crustaceans and fishes; Hormonal regulation of osmoregulation; Water and electrolyte balance; Stress physiology and adaptation		K2, K4
	Digestion – Digestion and absorption of carbohydrates, proteins and lipids; Gastrointestinal hormones; Regulation of digestion and absorption		K2, K4
Unit 2: Respiratory Physiology, Cardiovascular Physiology, and Excretory Physiology			
2	Respiration – Comparative physiology of respiration; Respiratory organs; Transport and exchange of gases; Oxygen dissociation curve; Lung volumes and capacities		K2, K4
	Blood and Circulation – Blood corpuscles and haemopoiesis; Plasma composition and functions; Blood groups, blood coagulation; Comparative anatomy and types of heart; Human cardiac cycle and cardiac output; Blood pressure and blood volume regulation		K2, K4
	Excretion – Excretory organs in animals; Comparative physiology of excretion; Structure and function of kidney; Mechanism of urine formation; Counter current mechanism; Micturition; Regulation of water balance and electrolyte balance		K2, K4
Unit 3: Nervous System, Muscle Contraction, and Sensory Receptors			
3	Nervous System – Diversity of Nervous Systems in animals; Organization of central and peripheral nervous system; Structure and function of neurons; Resting membrane potential and action potential and Impulse transmission; Synaptic transmission – synaptic plasticity; Neurotransmitters and receptors; Neural control of muscle tone and posture		K4, K5
	Muscle Physiology – Ultrastructure of skeletal muscle; Molecular mechanism of muscle contraction; Sliding filament theory; Neuromuscular junction; Smooth and skeletal muscle physiology – Muscle fatigue and disorders		K2, K4
	Sensory Physiology – Chemoreception (taste, smell); Photoreception – photochemistry of vision; Phonoreception – physiology of hearing; Tactile receptors and reflex action		K2, K4

Unit 4: Endocrine Glands, Hormones, and Signal Transduction Pathways			
4	Endocrine System – Classification of hormones; Endocrine glands – functions and secretion disorders; Hypothalamus and pituitary axis; Pineal gland; Thyroid and parathyroid glands; Pancreas and adrenal glands		K1, K2
	Hormonal regulation – Calcium and phosphorus metabolism, and stress hormones		K2, K4
	Cell signalling – Hormone receptors; Mechanism of hormone action (peptide and steroid hormones); Signal transduction pathways (cAMP, G-protein coupled receptors); Intracellular signaling pathways; Regulation of signaling pathways		K4, K5
Unit 5: Reproductive System, Neuroendocrine Regulation, and Animal Behavior			
5	Reproductive Physiology – Anatomy of reproductive systems; Hormonal regulation of reproduction; Menstrual cycle and hormonal control; Pregnancy, parturition and lactation		K2, K4
	Reproductive Health and Disorders – Polycystic Ovary Syndrome (PCOS), Menopause; Assisted Reproductive Technologies (IVF)		K2, K4
	Neuroendocrine Regulation – Neuroendocrine mechanism in insect growth and reproduction		K2, K4
	Behavioural Physiology – Biological rhythms; Types of behaviour – taxis, kinesis, reflex, learning; Bioluminescence – chemistry and significance; Behavioral endocrinology – biological rhythm		K2, K4
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand homeostasis, feedback mechanisms, thermoregulation, osmoregulation, and digestion and absorption of nutrients.
2. Comprehend comparative physiology of respiration, blood circulation, cardiac cycle, excretion, and nephron function.
3. Grasp neurophysiology including action potential and synaptic transmission, muscle contraction, and sensory mechanisms.
4. Recognize endocrine glands, hormone classification, hormonal regulation, and cell signaling pathways such as cAMP and GPCR.
5. Appreciate reproductive physiology, reproductive disorders, ART, and behavioural physiology including biological rhythms and learning.
6. Integrate understanding of physiological systems to explain homeostatic regulation, adaptations, and signal transduction.

Reference Books

1.	Hoar, W.S.1991. General and Comparative Physiology. Prentice Hall of India, New Delhi. Prosser, C.L. 1973.
2.	Comparative Animal Physiology, 3 rdedn. W.B. Saunders & Co., Philadelphia. Barrington, E.J.W.1975. An Introduction to General and Comparative Endocrinology. Clarendon Press, Oxford
3.	Schmidt Nelssen, K.1985. Animal Physiology. Adaptation and Environment Club, London
4.	Dee Unglaub Silverthorn (2010). Human Physiology: An integrated Approach. 5th Edition.Pearson Education Inc., New Jersey.
5.	Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XIEdition John Wiley & sons,

Textbooks

6.	Welson, A. 1979. Principles of Animal Physiology. McMillan Publishing Co. Inc. New York.
7.	Herkat, P.C.and Mathur, P.N.1976. Text Book of Animal Physiology. S. Chand Co. Pvt, Ltd., New Delhi.
8.	Bentley, P.J.1971. Endocrine and osmoregulation, Springer Verlag, New York.
9.	General Endocrinology - Turner C D and Bagnara JT, Saunders publication,1976. • Endocrinology: An Integrated Approach; Stephen Nussey and Saffron.
10.	Verma, P. S., Agarwal, V. K., & Tyagi, B. S. (2022). Animal physiology (18th ed.). S. Chand Publishing

Online Resources (Free or Accessible)

11.	**https://learninglink.oup.com/access/hill5e-student-resources?utm**
12.	**https://open.umn.edu/opentextbooks/textbooks/introductory-animal-physiology?utm**
13.	**https://www.brainscape.com/subjects/animal-physiology?utm**
14.	**https://fiveable.me/animal-physiology?utm**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average

CO1	3	3	1	1	1	2	1	2	**1.8**
CO2	3	3	2	2	1	2	2	2	**2.1**
CO3	3	3	2	2	1	1	2	2	**2.0**
CO4	3	3	1	2	2	1	3	2	**2.1**
CO5	3	2	1	1	1	1	3	2	**1.8**
CO6	3	3	2	2	2	2	3	3	**2.5**
Average	**3.0**	**2.8**	**1.5**	**1.7**	**1.3**	**1.5**	**2.3**	**2.2**	**2.043**

Final Overall Matrix Score = 2.043/3.00=68.1%

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-II

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

GENETICS

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

Course Outcomes (COs) for Genetics

On the successful completion of the course, student will be able to:

COs	Course Outcome	K Level
CO1	Explain classical and modern gene concepts, linkage, crossing over, quantitative inheritance, multiple alleles, sex-linked and autosomal inheritance, and sex determination mechanisms.	**K2, K4**
CO2	Describe the mechanisms of bacterial transformation, conjugation, transduction, and bacteriophage lambda life cycles.	**K2, K4**
CO3	Classify mutation types, explain molecular mechanisms of mutation and recombination, and analyze Holliday model.	**K4, K5**
CO4	Analyze human karyotype, identify chromosomal anomalies (numerical and structural), and explain inborn errors of metabolism.	**K2, K4**
CO5	Perform pedigree analysis, calculate recurrence risks, explain inbreeding/outbreeding, and describe Human Genome Project.	**K3, K4**
CO6	Explain the genetic basis of cancer, differentiate oncogenes from tumor suppressors, and discuss detection methods and epigenetics.	**K4, K5**

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

Pre-requisite knowledge: Basic knowledge on Cell theory, Mendelian inheritance, basic chemistry, molecular bonds and high school level mathematics.

Unit	Contents of the Course	Hrs	K. level
1	**Foundations of Heredity: Genes and Genes Interactions**		
	Classical gene concept – Mendelian concept; Linkage – coupling and repulsion-Crossing over – Stern experiment; Chromosome mapping		K1, K2
	Intergenic interaction-Complementary gens, Epistasis- dominant epistasis; Pleiotropism; Penetrance; Expressivity; Quantitative inheritance (Multiple genes) – human skin colour; Multiple alleles – ABO blood group		K2, K4
	Sex linked inheritance – Colour blindness; Autosome linked inheritance – Sickle cell anemia		K2, K4
	Sex determination in Human and Fowls; Genic balance theory and Lyon hypothesis; Modern gene concept – Fine structure of gene – Cistron, Recon, Muton		K2, K4
2	**Microbial Genetics**		
	Bacterial transformation – discovery, detection, competence, molecular mechanism		K2, K4
	Bacterial conjugation – insertion of F factor into *E. coli* chromosome, Hfr transfer, genetic recombination of F plasmids, mechanism of chromosomal transfer		K4, K5
	Virus Genetics – Transduction – DNA transfer; specialized and generalized transduction		K2, K4
	Bacteriophage – lambda phage – lambda DNA and its genetic structure; lytic and lysogenic cycle; early and late genes.		K2, K4
3	**Molecular Mechanisms of Mutation and Recombination**		
	Mutation – types; molecular mechanism – deletion, addition, substitution		K2, K4
	Spontaneous mutation – mutation rates; origin of spontaneous mutation – tautomeric and frameshift mutation; suppressor mutation		K4, K5
	Genetic recombination – breakage and reunion; heteroduplex DNA; single (Holliday model) and double stranded breaks		K4, K5
	Isolation and recombination intermediates; interallelic recombination; specialized recombination at specific sites		K4, K5
	Human Karyotype, Chromosomal Anomalies, and Inborn Errors of Metabolism		
	Human Karyotype and idiogram – banding techniques, FISH		K2, K4

4	Chromosomal non-disjunction mechanism – sex chromosome anomalies – Klinefelter and Turner syndrome		K2, K4
	Autosome anomalies – Down syndrome (Trisomy 21), Patau syndrome (Trisomy 13); Structural aberration – Translocation (chronic myelogenous leukemia – Philadelphia chromosome; Burkitt lymphoma – c-myc translocation)		K2, K4
	Inborn errors of metabolism – Phenylalanine amino acid metabolic mutation diseases		K2, K4
5	**Genetic Counseling, Human Genome Project, and Molecular Basis of Cancer**		
	Pedigree analysis – pedigree symbols- Genetic analysis and genetic counseling		K3, K4
	Inbreeding, outbreeding and hybrid vigour; Eugenics, Euthenics and Euphenics		K2, K4
	Human Genome Project (HGP) – goals, outcomes, and implications		K2, K4
	Genetic basis of human cancer – major cancer genes: RAS, MYC (oncogenes); TP53, BRCA1, BRCA2, APC (tumor suppressors)		K4, K5
	Detection of oncogenes and epigenetics application in cancer		K2, K4
	TOTAL HOURS	**72**	

1. **On the successful completion of the course the Learning Outcomes are**
2. Understand gene concepts, linkage, crossing over, chromosomal mapping, quantitative inheritance, and sex determination.
3. Comprehend bacterial transformation, conjugation, transduction, and bacteriophage lambda life cycles.
4. Grasp mutation types, explain molecular mechanisms, and analyze the Holliday model for recombination.
5. Recognize human karyotype, chromosomal anomalies, and inborn errors of metabolism including PKU and alkaptonuria.
6. Understand pedigree analysis, calculate recurrence risks, and describe Human Genome Project outcomes.
7. Appreciate the genetic basis of cancer, oncogenes versus tumor suppressors, detection methods, and epigenetics.

Reference Books

1.	David Friefelder 1990. Microbial genetics Narosa Pub. House, New Delhi. •
2.	Hartl and Jones 1998. Genetics–Principles and analysis Jones and Bart latt , Pub.
3.	Watson J.D., Hopkins, N.H., Roberts, J.W., Steitz, J.A., and Weiner, A.M. 1987. Molecular biology of Gene I & II
4.	Lewin's Genes XII Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, Jones & Bartlett Learning
5.	Molecular Biology of the Gene (7th Edition) James D. Watson, Tania A. Baker, et al.Cold Spring Harbor Laboratory Press

Textbooks

6.	Gardner. A & Davies. T, 2010. Human Genetics, Viva Books, New Delhi
7.	Principles of Genetics (7th Edition) D. Peter Snustad & Michael J. SimmonsJohn Wiley & Sons
8.	**Gupta, P. K.** (2020). *Genetics* (5th ed.). Rastogi Publications.
9.	**Gangane, S. D.** (2025). *Human genetics* (7th ed.). Elsevier Health Sciences.
10.	**Datta, A. K.** (2015). *Essentials of medical genetics* (5th ed.). A.R.K. Publication.

Online Resources (Free or Accessible)

11.	**NCBI – Genetics & Medicine Educational Portal https://www.ncbi.nlm.nih.gov/books/NBK1116**
12.	**Online Mendelian Inheritance in Man (OMIM) Database https://omim.org**
13.	**https://ocw.mit.edu/courses/hst-161-molecular-biology-and-genetics-in-modern-medicine-fall-2007/**
14.	**https://learn.genetics.utah.edu/**
15.	**https://www.ncbi.nlm.nih.gov/guide/genetics-medicine/**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	1	1	1	1	2	2	**1.6**
CO2	3	3	2	2	2	1	2	2	**2.1**
CO3	3	3	1	2	1	1	2	2	**1.9**
CO4	3	3	2	2	2	1	3	2	**2.3**
CO5	3	3	1	3	2	1	2	3	**2.3**
CO6	3	3	2	2	2	1	3	3	**2.4**
Average	**3.0**	**2.8**	**1.5**	**2.0**	**1.7**	**1.0**	**2.3**	**2.3**	**2.086**

Final Overall Matrix Score = 2.086/3.00=69.53%

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LAB COURSE II

(CELL AND MOLECULAR BIOLOGY, COMPARATIVE ANIMAL PHYSIOLOGY & GENETICS)

Core Paper-	**Credits:2**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

CO	Course Outcome	K Level
CO1	Demonstrate proficiency in preparing, staining, and observing mitotic and meiotic chromosomes using onion root tips and grasshopper testis squash preparations.	K2, K4
CO2	Perform isolation, spectrophotometric quantification, and integrity checking of DNA from chicken liver/spleen tissue.	K2, K4
CO3	Calibrate an ocular micrometer using a stage micrometer and accurately measure microscopic objects (RBCs, WBCs, cells).	K2, K4
CO4	Analyze osmotic fragility of RBCs by measuring haemolysis across varying NaCl concentrations and determine mean corpuscular fragility (MCF).	K4, K5
CO5	Estimate haemoglobin concentration using Sahli's method and interpret results relative to normal ranges.	K2, K4
CO6	Apply Chi-square (χ^2) analysis to monohybrid and dihybrid cross data to accept or reject the null hypothesis.	

MAJOR PRACTICALS

S.No.	Practical Title	Subject / Material	Key Observation Points	Evaluation Basis
1	Preparation and Staining of Mitotic Chromosomes from Onion Root Tip	**Cell biology** *Allium cepa (Onion root tip)*	Grow onion roots; fix root tips in Carnoy's fluid; hydrolyze in 1N HCl; stain with Aceto-orcein or Feulgen stain; identify prophase, metaphase, anaphase, telophase; calculate mitotic index.	Diagram + Labelling + Identification
2	Isolation and Spectrophotometric Quantification of DNA from Chicken Liver / Spleen	**Molecular biology** *Chicken liver / spleen tissue*	Homogenize tissue; lyse cells with SDS and Proteinase K; perform phenol-chloroform extraction; precipitate DNA with ice-cold ethanol; quantify at A_{260}/A_{280}; check integrity on 0.8% agarose gel.	Procedure + Calculation + Result
3	Micrometry – Calibration of Ocular Micrometer Using Stage Micrometer	**Cell biology** *Microscope + stage/ocular micrometers*	Calibrate ocular micrometer at 10X, 40X, 100X; measure diameter of RBC, WBC, pollen grains, epithelial cells; calculate actual size in micrometres.	Calculation + Diagram + Identification
4	Study of Osmotic Fragility of RBCs (Human / Rat)	**Animal physiology** *Human or rat blood*	Prepare RBC suspension (1:1000); add to NaCl concentrations 0.1%–1.0%; centrifuge; measure haemolysis at A540; plot % haemolysis vs NaCl concentration; determine mean corpuscular fragility (MCF).	Graph + Calculation + Result
5	Estimation of Haemoglobin by Sahli's Method	**Animal physiology** *Human blood (finger prick / anticoagulated)*	Collect blood; add to N/10 HCl in Sahli's tube; dilute with distilled water until colour matches standard; read Hb concentration (g/dL); note normal range: 12–16 g/dL (women), 14–18 g/dL (men).	Calculation + Observation + Result
6	Chi-Square (χ^2) Analysis of Dihybrid Cross Data	**Genetics** *mono and dihybrid crass, Pea plant data / seed data*	Monohybrid cross (3:1): count tall vs dwarf plants. Dihybrid cross (9:3:3:1): count seed phenotypes. Apply $\chi^2 = \Sigma(O-E)^2/E$; compare with table value (df = n−1, p = 0.05); accept or reject null hypothesis.	Calculation + Table + Result
7	Study of Human Genetic Traits and Pedigree	**Genetics** *Traits*	Assess mendelian traits and calculate trait frequency. Construct and analyse pedigrees	Pedigree Diagram +

	Analysis	*identification. Draw a pedigree charts for given problems patten inheritance*	for autosomal dominant (sickle cell anaemia, X-linked recessive (colour blindness); determine genotypes.	Genotype + Viva

MINOR PRACTICALS

S.No.	Practical Title	Type	Points to Study
1.	Demonstration of Osmosis and Cell Permeability Using RBCs in Different NaCl Concentrations	*Physiology / Biochemistry*	Prepare RBC suspension (1:1000); add to NaCl concentrations 0.1%, 0.5%, 0.9%, 1.5%, 2.0%; observe haemolysis (clear red solution) vs intact cells; determine isotonic point (0.9% NaCl).
2.	Demonstration of DNA Isolation from Onion (Household Chemicals – Simple Method)	*Molecular Biology*	Chop onion; add detergent (SDS/soap) + salt (NaCl); incubate at 60°C for 15–20 min; filter; add cold ethanol slowly; spool out white thread-like DNA on glass rod.
3.	Mounting of Salivary Gland Polytene Chromosomes from Chironomus / Drosophila Larva	*Cytology slide*	Dissect salivary gland; stain with Aceto-orcein; squash; prepare slide showing banding pattern and puffs (Balbiani rings).
4.	Determination of Blood Pressure (BP) and Pulse Rate in Human Volunteer	*Animal Physiology*	Use sphygmomanometer and stethoscope; record systolic and diastolic BP (normal 120/80 mm Hg); calculate pulse rate (normal 60–100 beats per minute).
5.	Blood grouping (ABO & Rh typing)	Genetics	Use anti-antibody to determine the blood groups and understand the genetics behind it
6.	Mounting of Drosophila (Male vs Female) – Identification of Sexual Dimorphism	*Genetics specimen*	Prepare permanent slide of male and female Drosophila; identify male (smaller body, dark abdomen, sex combs on forelegs) vs female (larger body, light abdomen, pointed abdominal tip).

SPOTTERS (specimens /Instrument / slides per)

S.No.	Specimen / Organism	Material Type	Points to Observe
Microscopy & Cell Structures			
1	**Compound Microscope**	*Instrument*	Objective lenses (4X, 10X, 40X, 100X), eyepiece (10X), condenser, coarse/fine focus; magnification and resolution of cellular structures.
2	**Haemocytometer (Neubauer's Chamber)**	*Thick glass slide*	Counting grids (9 squares of 1 mm²); counting RBCs, WBCs, platelets, sperm cells; cell density calculation.
Cell Division & Chromosomes			
3	**Tissues Mitosis stages**	*Slide (stained)*	Prophase (condensed chromosomes), Metaphase (chromosomes at equator), Anaphase (separating chromatids), Telophase (two nuclei); calculation of mitotic index.
4	**Meiosis Stages**	*Slide (stained)*	Diakinesis, Metaphase I (bivalents at equator), Anaphase I (homologous chromosomes separate), Telophase II (four haploid cells); study of crossing over and genetic diversity.
Molecular Biology Techniques			
5.	**Agarose Gel Electrophoresis Unit**	*Instrument*	Tank with combs (to form wells), gel tray, electrodes, power supply; separation of DNA/protein fragments by size; analysis of PCR products.
6.	**PCR Thermal Cycler (Thermocycler)**	*Instrument*	Heating block with heated lid, programmable temperature cycles, display screen; amplification of specific DNA sequences (denaturation, annealing, extension).
7.	**Microcentrifuge Tube (Eppendorf Tube)**	*Glassware / Plasticware*	Small plastic tube with snap cap (0.2 ml, 0.5 ml, 1.5 ml, 2.0 ml); storing and centrifuging small volumes of DNA, RNA, protein samples.
8.	**Micropipettes (P10, P20, P100, P200, P1000)**	*Instrument*	Adjustable pipettes with disposable tips (0.5 µl – 1000 µl range); accurate dispensing of microlitre volumes for molecular biology experiments.
Haematology			

9	**Wintrobe's Haematocrit Tube**	*Instrument*	Graduated tube (110 mm) with 0–100 mm markings; packed cell volume (PCV) measurement.
10	**Blood Smear (Leishman / Wright Stained Slide)**	*Microscopy slide*	RBCs (biconcave), WBCs (neutrophils – segmented nuclei; lymphocytes – large nucleus; eosinophils – red granules; basophils – blue granules; monocytes – kidney-shaped nucleus), platelets; differential leukocyte count (DLC).
11	**ESR Tube (Westergren)**	*Instrument*	Graduated pipette (200 mm) with 0–200 mm markings; erythrocyte sedimentation rate – indicator of inflammation.
Cardiovascular & Respiratory			
12	**ECG Paper Strip (Normal)**	*Physiograph record*	P wave (atrial depolarisation), QRS complex (ventricular depolarisation), T wave (ventricular repolarisation), PR interval, QT interval; diagnosis of cardiac arrhythmias, ischaemia, myocardial infarction.
13	**Spirometer**	*Instrument*	Recording drum with rotating kymograph and breathing tube; measures lung volumes and capacities (tidal volume, vital capacity, FEV1).
14	**Mammalian Ringer Solution (Bottle)**	*Reagent*	Clear colourless solution (Na+, K+, Ca2+, Cl−, HCO3−, glucose); physiological saline for rat/rabbit isolated organ studies.
Genetics & Heredity			
15.	**Down Syndrome Karyotype (47,XX,+21 or 47,XY,+21)**	*Photomicrograph*	Three copies of chromosome 21 (Trisomy 21); aneuploidy due to non-disjunction during meiosis; intellectual disability, characteristic facial features.
16.	**Klinefelter Syndrome Karyotype (47,XXY)**	*Photomicrograph*	Male karyotype with extra X chromosome; gynecomastia, tall stature, small testes, infertility; 1 Barr body present.
17.	**Turner Syndrome Karyotype (45,XO)**	*Photomicrograph*	Female karyotype with single X chromosome; short stature, webbed neck, streak gonads, infertility; no Barr body.
18.	**Cri-du-Chat Syndrome Karyotype (46,XX/XY,5p−)**	*Photomicrograph*	Deletion of short arm of chromosome 5; cat-like cry in infants, microcephaly, intellectual disability.
19.	**Chromosome 22**	*Philadephia chromososme*	Translocation- Leukemia
20.	**Drosophila – Red-Eyed Male (Specimen)**	*Preserved specimen*	Red eyes (wild type – w+ allele on X chromosome); normal eye colour; Morgan's experimental organism.
21.	**Drosophila – White-Eyed Male (Specimen)**	*Preserved specimen*	White eyes (mutant); X-linked recessive mutation (w allele); Morgan's experiment – proved genes are located on chromosomes.
22.	**Drosophila – White-Eyed Female (Specimen)**	*Preserved specimen*	Homozygous recessive female (w/w); white eyes; demonstrates sex-linked inheritance pattern.
23.	**DNA Fingerprint (RFLP Autoradiogram)**	*Photograph / printout*	Band patterns (restriction fragments separated by size); forensic identification, paternity testing, individual identification (except identical twins).
24.	**Restriction Enzyme Tube (EcoRI)**	*Reagent tube*	Enzyme in storage buffer (50% glycerol) with BSA; cuts DNA at specific recognition sequence (GAATTC – palindromic); used in recombinant DNA technology.
25.	**Agarose Gel with DNA Bands (Photograph)**	*Photograph / printout*	Separated DNA fragments (bands) of different sizes visualised with ethidium bromide / GelRed; DNA fingerprinting – identification by size comparison with ladder.

Cells and Tissues

26.	**Squamous Epithelial Cell**	Slide (stained)	Physiology: Rapid diffusion & filtration. Found in Bowman's capsule of the kidney (ultrafiltration) and lung alveoli (gas exchange).
27.	**Columnar Epithelial Cell**	Slide (stained)	Physiology: Secretion (stomach acid/enzymes) and Absorption (nutrients in the small intestine). Goblet cells secrete mucus for lubrication.
28.	**Neuron (Nerve Cell)**	Slide (stained)	Physiology: Conducts electrical impulses. Transmits signals from CNS to effectors (muscles/glands) for rapid response to stimuli.
29.	**Cardiac Muscle Fiber**	Slide (stained)	Physiology: Rhythmic involuntary contraction. Intercalated discs allow rapid spread of electrical impulses (syncytium) for coordinated heart pumping.

30.	**Skeletal Muscle Fiber**	Slide (stained)	Physiology: Voluntary movement. Actin-myosin cross-bridge cycling generates force for locomotion and breathing.
31.	**Ciliated Columnar Epithelium**	Slide (stained)	T.S. Trachea / Fallopian Tube,Tall cells with hair-like cilia on the apical surface; interspersed with goblet cells. Physiology: Mucociliary clearance & Gamete transport. Cilia beat synchronously to sweep mucus (trachea) or move the ovum (fallopian tube) in a specific direction.
32.	**Areolar (Loose) Connective Tissue**	Slide (stained)	Permanent Slide (under skin) Gel-like matrix; fibroblasts; collagen and elastic fibers loosely arranged. Physiology: Support & Immunity. Wraps and cushions organs; provides a reservoir for water and salts; macrophages in it fight infection.
33.	**Adipose Tissue**	Slide (stained)	Permanent Slide (Fat) Large, empty-looking cells (adipocytes) with nuclei pushed to the periphery. Physiology: Energy storage & Insulation. Stores triglycerides for long-term energy; acts as a shock absorber and thermal insulator.
34.	**Hyaline Cartilage**	Slide (stained)	T.S. Trachea / Joint surface Glassy matrix; chondrocytes in lacunae (small spaces); avascular. Physiology: Reduces friction. Provides smooth, low-friction surfaces at joints; supports the trachea to keep airways open.
35.	**Bone (Compact / Cancellous)**	Slide (stained)	T.S. Bone / Frog Skeleton Haversian systems (osteons); concentric lamellae around central canal; osteocytes in lacunae. Physiology: Mineral homeostasis & Hematopoiesis. Stores Calcium & Phosphorus; yellow marrow stores fat; red marrow produces blood cells.
36.	**Skeletal (Striated) Muscle Tissue**	Slide (stained)	T.S. Tongue / Limb muscle Cylindrical fibers with multiple peripheral nuclei; distinct alternating dark (A) and light (I) bands. Physiology: Voluntary rapid contraction. Generates heat (thermogenesis) and enables posture, movement, and breathing.
37.	**Smooth (Non-striated) Muscle Tissue**	Slide (stained)	T.S. Stomach / Intestine / Artery Spindle-shaped cells; single central nucleus; no striations. Physiology: Involuntary slow contraction (Peristalsis). Regulates diameter of blood vessels (vasoconstriction), moves food via peristalsis, and expels urine/baby.
38.	**Nervous Tissue**	Slide (stained)	T.S. Spinal Cord Composed of neurons (impulse conduction) and neuroglia (supporting cells). Grey matter has cell bodies; white matter has myelinated axons. Physiology: Rapid communication. Neuroglia (like Schwann cells) produce myelin sheath for saltatory conduction (faster impulse transmission).

LO No.	Learning Outcome	Related CO
LO1	Prepare, stain, and identify mitotic stages (prophase, metaphase, anaphase, telophase) from onion root tip squash and meiotic stages from grasshopper testis squash.	**CO1**
LO2	Isolate DNA from chicken liver/spleen using phenol-chloroform extraction, quantify purity at A260/A280, and check integrity on agarose gel.	**CO2**
LO3	Calibrate ocular micrometer using stage micrometer at 10X, 40X, and 100X magnifications and measure actual size of RBCs, WBCs, and epithelial cells in micrometres.	**CO3**
LO4	Perform RBC osmotic fragility test across NaCl concentrations (0.1%–1.0%), calculate % haemolysis, plot graph, and determine mean corpuscular fragility (MCF).	**CO4**
LO5	Estimate haemoglobin concentration using Sahli's haemoglobinometer and apply Chi-square analysis ($\chi^2 = \Sigma(O-E)^2/E$) to monohybrid (3:1) and dihybrid (9:3:3:1) cross data.	**CO5**
LO6	Determine ABO and Rh blood groups using antisera, assess human genetic traits (PTC tasting, tongue rolling, earlobe type), and analyze pedigrees for autosomal dominant/recessive and X-linked recessive disorders.	**CO6**

CO-PO Correlation Strength Matrix (Practical II)

Strength: 3 = Strong, 2 = Moderate, 1 = Weak

CO	**PO1**	**PO**	**PO3**	**PO**	**PO**	**PO6**	**PO7**	**PO8**	**Aver**

		2		**4**	**5**				**age**
CO1 (Mitosis & Meiosis preparation)	3	2	3	2	1	2	2	2	**2.1**
CO2 (DNA isolation & quantification)	3	3	3	3	1	2	2	2	**2.4**
CO3 (Micrometry & calibration)	3	3	2	3	1	1	2	2	**2.1**
CO4 (RBC osmotic fragility)	3	3	3	2	1	2	2	2	**2.3**
CO5 (Hb estimation & Chi-square)	3	3	3	2	2	2	2	2	**2.4**
CO6 (Blood grouping, traits & pedigree)	3	3	2	2	2	2	3	2	**2.4**
Average	**3**	**2.83**	**2.83**	**2.33**	**1.33**	**1.83**	**2.16**	**2**	**2.29**

Final Overall Matrix Score = 2.286/3.00=76.2%

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MICROBIOLOGY

Elective Paper-	**Credits:4**	**Paper Code:**
Total Contact Hours:60		**Weekly Contact Hours: 5**

Course Outcomes (COs) for Microbiology

COs	Course Outcome	K Level
CO1	Explain the history of microbiology, contributions of Pasteur, Koch, and Fleming; Whittaker's five kingdom classification; bacterial structure (cell wall, flagella, pili, capsule); and modern taxonomic methods (ribotyping, 16S rRNA sequencing).	**K2, K4**
CO2	Explain bacterial nutrition (autotrophs, heterotrophs, phototrophs, chemotrophs), growth curve, culture methods, types of culture media, and factors affecting microbial growth.	**K2, K4**
CO3	Describe virus classification (Baltimore), structure of HIV and T4 phage, lytic and lysogenic cycles; fungal structure and classification; viroids and prions.	**K2, K4**
CO4	Explain physical and chemical methods of microbial control, mechanisms of antibiotic action, and mechanisms of antibiotic resistance.	**K2, K4**
CO5	Identify causative agents of common bacterial and viral diseases; explain food spoilage, foodborne illnesses, probiotics, and prebiotics.	**K2, K4**
CO6	Explain bioremediation, oil-degrading bacteria, biopesticides, and industrial fermentation processes (alcohol, yogurt, bread, penicillin, protease).	**K2, K4**

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

Pre-requisite knowledge: General Biology, Biochemistry, and Genetics, which provide the essential context of cell structure, metabolic pathways, and Laboratory usage

Unit	Topic Name	Hr	K. level
Unit 1: Foundations of Microbiology and Bacterial Structure			
1	History and scope of Microbiology – Contribution of Louis Pasteur, Robert Koch and Alexander Fleming		**K1, K2**
	Classification of microorganisms – Whittaker's five kingdom concept		**K1, K2**
	Bacteria – with special reference to cell wall, flagella, pilus, capsule		**K2, K4**
	Bacterial identification, nomenclature and classification New approaches to bacterial taxonomy / classification including ribotyping and ribosomal RNA sequencing		**K2, K3**
Unit 2: Bacterial Growth, Nutrition, and Culture Methods			
2	Culture of aerobic and anaerobic microorganisms		**K2, K3**
	Bacterial nutrition – autotrophs vs. heterotrophs; phototrophs, chemotrophs, saprophytes, parasites		**K2, K4**
	Bacterial growth – binary fission; bacterial growth curve (lag, log, stationary, death phases)		**K2, K3**
	Types of culture media, measurement of growth and methods of maintenance of culture		**K2, K3**
	Factors affecting microbial growth – temperature, pH, oxygen, moisture, osmotic pressure		**K2, K4**
Unit 3: Viruses, Fungi, and Sub-viral Particles			
3	Classification of viruses – Baltimore classification		**K2, K4**
	Detailed morphology and structure of virus (HIV and T4 phage)		**K2, K4**
	Lytic and lysogenic cycle		**K2, K4**
	Fungi – structure (hyphae, mycelium, yeast); classification (molds, yeasts, mushrooms) Viroids and Prions		**K2, K4**
Unit 4: Sterilization, Disinfection, and Antibiotics			
4	Sterilization and disinfection – definitions; physical methods (heat – autoclaving, pasteurization; filtration; radiation)		**K2, K3**
	Chemical methods of control – antiseptics, disinfectants (alcohols, halogens, phenolics, aldehydes)		**K2, K3**
	Antibiotics – discovery of penicillin (Alexander Fleming); mechanisms of action (cell		**K2, K4**

	wall synthesis inhibitors, protein synthesis inhibitors)		
	Antibiotic resistance (mechanisms and prevention)		**K4, K5**
	Sterilization and disinfection – definitions; physical methods (heat – autoclaving, pasteurization; filtration; radiation)		**K2, K3**
	Chemical methods of control – antiseptics, disinfectants (alcohols, halogens, phenolics, aldehydes)		**K2, K3**
Unit 5: Applied Microbiology			
5	Medical microbiology – common bacterial diseases (tuberculosis – TB, cholera); viral diseases (COVID-19, HIV/AIDS); modes of transmission		**K2, K4**
	Food microbiology – food spoilage (causes, prevention); foodborne illnesses (botulism); probiotics and prebiotics		**K2, K4**
	Environmental microbiology – bioremediation; oil-degrading bacteria (oil superbug) and biopesticides		**K2, K4**
	Industrial microbiology – fermentation technology (production of alcohol, yogurt, bread); production of antibiotics (penicillin), enzyme – protease		**K2, K4**
	Medical microbiology – common bacterial diseases (tuberculosis – TB, cholera); viral diseases (COVID-19, HIV/AIDS); modes of transmission		**K2, K4**
	TOTAL HOURS	48	

On the successful completion of the course the Learning Outcomes are

1. Understand the history of microbiology, five-kingdom classification, bacterial structure, and modern taxonomic methods.
2. Comprehend bacterial nutrition, growth curve, culture methods, media types, and factors affecting microbial growth.
3. Grasp virus classification, structure of HIV and T4 phage, lytic and lysogenic cycles, fungi, viroids, and prions.
4. Recognize physical and chemical methods of microbial control, antibiotic mechanisms, and antibiotic resistance strategies.
5. Understand bacterial and viral diseases, food spoilage, foodborne illnesses, probiotics, and prebiotics.
6. Appreciate bioremediation, biopesticides such as Bt, and industrial fermentation processes for antibiotics and enzymes.

Reference Books

1.	Pelczer, M. J. and Reid, R. D. (1990).Microbiology.McGraw Hill Book Company, New York Atlas,
2.	M., Ronald. (2013). Principles of Microbiology. II Ed. WCB McGraw Hill, Boston.
3.	Black, G., Jacquelyn (1996). Microbiology – Principles and Applications III. Ed. Prentice Hall, Upper Saddle River, NewJercy. Casida, L. E. (1999).
4.	Prescott's Microbiology, VIII Ed. McGrawHill International, Boston. Stainer, R .Y., Ingraham, J. L., Wheelis, M. L. and Painter, P.R. (2008) General Microbiology, Macmillan, London.
5.	Talaro, P. K. and Talaro, A. (2009).] Foundations in Microbiology III Ed. WCB McGraw Hill, Boston.

Textbooks

6.	Ananthanarayanan, R. and JeyaramPaniker, C. K. (2010). Textbook of Microbiology. Orient Longman limited, Madras.
7.	A Text book of Microbiology. S. Chand and Company Ltd. Joanne, M., Linda,W., Sherwood,M. and Christopher, J. W.(2014).
8.	Dubey, R. C. (2010). A textbook of microbiology. New Delhi, India: S. Chand & Company.
9.	Jain, A., & Jain, P. (2019). Essentials of microbiology. New Delhi, India: Elsevier India
10.	Parija, S. C. (2016). Textbook of microbiology and immunology (3rd ed.). New Delhi, India: Elsevier India.

Online Resources (Free or Accessible)

11.	https://epgp.inflibnet.ac.in/?utm
12.	https://asm.org/?utm
13.	https://ocw.mit.edu/courses/1-89-environmental-microbiology-fall-2004/?utm
14.	https://microbenotes.com/?utm

PO–CO Correlation Strength Matrix

Strength: 3 = Strong, 2 = Moderate, 1 = Weak

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	1	1	2	1	1	2	**1.6**
CO2	3	2	2	2	1	1	1	2	**1.8**
CO3	3	2	1	1	1	1	2	2	**1.6**
CO4	3	3	2	2	1	1	3	2	**2.1**
CO5	3	3	1	1	1	2	3	2	**2.0**
CO6	3	2	1	2	1	3	1	2	**1.9**
Average	**3.0**	**2.3**	**1.3**	**1.5**	**1.2**	**1.5**	**1.8**	**2.0**	**1.828**

Final Overall Matrix Score = 1.828/3.00=60.93%

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ENTOMOLOGY

Elective Paper-	**Credits:4**	**Paper Code:**
Total Contact Hours:60		**Weekly Contact Hours: 5**

Course Outcomes (COs) for Entomology

COs	Course Outcome	K Level
CO1	Define entomology, classify insects into major orders, and identify external body parts and mouthpart types.	K1, K2, K3
CO2	Explain insect physiology (digestive, respiratory, circulatory, excretory, nervous, reproductive systems) and types of metamorphosis.	K2, K3
CO3	Describe insect habitats, population ecology, plant-insect interactions, insect behavior, and migration.	K2, K4
CO4	Define pest, explain EIL/ETL, describe IPM strategies, biological control, and chemical control methods.	K2, K4
CO5	Identify insect vectors of human and animal diseases, household pests, and beneficial insects.	K1, K2
CO6	Explain the economic importance of beneficial insects (pollinators, silkworm, honey bees) and forensic entomology.	K2, K4

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

Pre-requisite knowledge: Basic understanding on insects biology and physiology

Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Introduction to Entomology and Insect Morphology			
1	Definition, scope and importance of entomology; why study insects? (insects in agriculture, medicine, ecology, and forensics)		K1, K2
	Classification of insects – major orders with common examples (Coleoptera – beetles, Lepidoptera – butterflies/moths, Diptera – flies, Hymenoptera – ants/bees/wasps, Orthoptera – grasshoppers, Hemiptera – bugs, Odonata – dragonflies)		K1, K2
	External morphology – body regions (head, thorax, abdomen); types of mouthparts (chewing, piercing-sucking, sponging, siphoning); types of antennae; types of legs (walking, jumping, grasping, swimming); types of wings		K2, K3
	Exoskeleton and body wall – structure (cuticle layers), functions (protection, waterproofing, muscle attachment), molting process		K2, K4
Unit 2: Insect Physiology			
2	Digestive system – structure of alimentary canal (foregut, midgut, hindgut), types of digestion		K2, K3
	Respiratory system – tracheal system (spiracles, tracheae, tracheoles); how insects breathe		K2, K3
	Circulatory system – open circulatory system, dorsal vessel (heart and aorta), hemolymph		K2, K3
	Excretory system – Malpighian tubules, role in excretion and water conservation		K2, K3
	Nervous system – brain (supraesophageal ganglion), ventral nerve cord, sense organs (simple eyes – ocelli, compound eyes)		K2, K3
Unit 3:Development Ecology and Behavior			
	Reproductive system – male and female reproductive organs, types of reproduction (sexual, parthenogenesis, viviparity)		K2, K3
	Insect development – metamorphosis types (ametabolous – no change, hemimetabolous – incomplete, holometabolous – complete); life cycle of silkworm/housefly as example; diapause		K2, K4
	Insect population ecology – population growth (fast reproduction), factors affecting population (food, climate, predators, disease)		K2, K4
	Insect behavior – types of behavior (feeding, mating, parental care, territoriality); communication (sound – cricket, light – firefly, chemicals – pheromones); social insects (honey bees, ants, termites) – caste system (queen, worker, drone), division of labor		K2, K4

Unit 4: Insect Pest Management			
-4	definition, types of pests (agricultural pests, household pests, stored grain pests, disease vectors); examples (locusts – crop pest, mosquitoes – disease vector, cockroach – household pest, termite – wood pest)		K1, K2
	Integrated Pest Management (IPM) – definition, principles; simple IPM strategies (cultural – crop rotation, clean fields; mechanical – hand picking, traps; biological – using natural enemies; chemical – using pesticides only when needed)		K2, K4
	Biological control – using natural enemies (predators – ladybird beetles, lacewings; parasitoids – tiny wasps; pathogens – Bacillus thuringiensis – Bt, NPV virus); advantages over chemical pesticides		K2, K4
	Chemical control – types of insecticides (natural – neem, pyrethrum; synthetic – organophosphates, carbamates, pyrethroids); how to use safely; problem of insecticide resistance		K2, K4
Unit 5: Medical, Veterinary, and Beneficial Insects			
-5	Medical entomology – insects that spread diseases (vectors); major insect vectors: Mosquitoes:malaria; Aedes – dengue, chikungunya, Culex – filariasis, Japanese encephalitis		K2, K4
	Flies: Glossina (tsetse) – sleeping sickness; Phlebotomus (sandfly) – kala-azar; Musca (housefly) – typhoid, diarrhea		K2, K4
	Household and stored product pests – cockroaches, ants, termites, bed bugs, silverfish; stored grain pests (Tribolium – flour beetle, Sitophilus – rice weevil, Callosobruchus – pulse beetle); simple control methods		K2, K3
	Beneficial insects – importance of insects in nature and human life:Pollinators (honey bees, bumble bees, butterflies); Silkworm (Bombyx mori) ;Honey bees; Insects as food (entomophagy) – for humans, birds, fish; Insects in research – Drosophila melanogaster (fruit fly) in genetics research		K2, K4
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand entomology, classify insect orders, identify body parts, mouthparts, antennae, wings, and exoskeleton.

2. Comprehend insect physiology covering digestive, respiratory, circulatory, excretory, nervous, and reproductive systems.

3. Grasp insect habitats, population ecology, plant-insect interactions, behavior, and migration.

4. Recognize pest definition, understand EIL and ETL, integrated pest management strategies, biological control, and chemical control methods.

5. Understand insect vectors of diseases, household pests, stored grain pests, and beneficial insects.

6. Appreciate the economic importance of beneficial insects including pollinators, silkworm, and honey bees, along with entomophagy and forensic entomology.

Reference Books

1.	Borror and DeLong's Introduction to the Study of Insects (7th Edition) Charles A. Triplehorn& Norman F. Johnson Brooks Cole
2.	Insects: Their Natural History and Diversity Stephen A. Marshall Firefly Books
3.	Medical and Veterinary Entomology (3rd Edition) Gary R. Mullen & Lance A. DurdenAcademic Press
4.	Pest Management: A Simple Guide D. P. Abrol Not specified

Textbooks

5.	David, B. V., & Ramamurthy, V. V. (2017). Elements of economic entomology (8th ed.). Brillion Publishing.
6.	Sehgal, P. K. (2018). Entomology: An illustrated textbook. New India Publishing Agency.
7.	Prakash, A. (2000). Laboratory manual of entomology. New Age International.
8.	Entomology: A Simple Introduction(2000).yK. P. Srivastava

Online Resources (Free or Accessible)

9.	iNaturalist – Insects Citizen Science https://www.inaturalist.org
10.	Khan Academy – Entomology Basics Video Library https://www.khanacademy.org (Search: Insects)
11.	University of Florida – Featured Creatures Educational Database https://entnemdept.ufl.edu/creatures

PO–CO Correlation Strength Matrix

Strength: 3 = Strong, 2 = Moderate, 1 = Weak

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	Average
CO1	3	2	2	3	3	2	2	2	**2.38**

CO2	3	2	2	1	1	1	1	2	**1.63**
CO3	3	3	2	1	2	2	1	2	**2.00**
CO4	3	3	2	2	2	3	2	2	**2.38**
CO5	3	2	2	2	1	2	3	2	**2.13**
CO6	3	2	2	1	1	2	2	2	**1.88**
Average	**3.00**	**2.33**	**2.00**	**1.67**	**1.67**	**2.00**	**1.83**	**2.00**	**2.063**

Final Overall Matrix Score = 2.063/3.00=68.76%

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NUTRITION FOR WELLBEING

Non Major Elective-	**Credits:2**	**Paper Code:**
Total Contact Hours:36		**Weekly Contact Hours: 3**

Course Outcomes (COs) for Nutrition for Well being

COs	Course Outcome	K Level
CO1	Explain the basic concepts of nutrition, classify nutrients (macro and micronutrients), and describe their functions and sources.	K2, K3
CO2	Describe the process of digestion, absorption, and metabolism; plan a balanced diet using "My Plate" guidelines and RDA.	K2, K4
CO3	Explain nutritional requirements across different life stages (infancy, adolescence, pregnancy, old age) and identify nutritional deficiencies.	K2, K4
CO4	Describe therapeutic diets for common lifestyle diseases (diabetes, hypertension, obesity, gastrointestinal, kidney, and liver diseases).	K2, K4
CO5	Calculate BMI and BMR, explain energy balance, and apply weight management strategies.	K3, K4
CO6	Evaluate popular modern diets (keto, intermittent fasting, vegan) and debunk common nutrition myths using scientific evidence.	K4, K5

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

Pre-requisite knowledge: Basic human biology, the digestive process, and the core components of a healthy diet

Unit	Topic Name	Hrs.	K. level
Unit 1: Introduction to Nutrition and Basic Nutrients			
Unit 1	Definition of nutrition, dietetics, health, and wellness; importance of good nutrition for overall well-being		K1, K2
	Classification of nutrients – macronutrients (carbohydrates, proteins, fats) and micronutrients (vitamins, minerals); water as an essential nutrient		K1, K2
	Carbohydrates – sources, classification (simple and complex), functions, dietary fibre (soluble and insoluble);		K2, K3
	Proteins – sources (animal and plant), amino acids (essential and non-essential), functions, nitrogen balance; deficiency		K2, K3
	Fats and Lipids – sources (saturated, unsaturated, trans fats), functions, essential fatty acids (omega-3, omega-6), cholesterol – good (HDL) vs. bad (LDL)		K2, K4
Unit 2: Micronutrients, Digestion, and Balanced Diet			
Unit 2	Vitamins – fat-soluble (A, D, E, K) and water-soluble (B-complex, C); sources, functions, deficiency diseases (scurvy, rickets, beriberi, night blindness)		K1, K2
	Minerals – major minerals (calcium, phosphorus, magnesium, sodium, potassium) and trace elements (iron, iodine, zinc, selenium); functions and deficiency disorders		K1, K2
	Digestion, absorption, and metabolism of nutrients – overview of digestive system; how carbohydrates, proteins, and fats are broken down and absorbed		K2, K3
	Balanced diet – definition, concept of My Plate for the Day (ICMR-NIN 2024 guidelines) – proportions of cereals, pulses, vegetables, fruits, milk, nuts, and oils		K2, K3
	Recommended Dietary Allowances (RDA) and Estimated Average Requirements (EAR) – ICMR 2020 guidelines; factors affecting nutritional requirements (age, sex, activity level, pregnancy, lactation)		K2, K4
Unit 3: Nutrition Across the Life Cycle			
Unit -3	Nutrition during infancy and childhood – breast milk vs. formula; complementary feeding; common nutritional problems (protein-energy malnutrition – marasmus, kwashiorkor)		K2, K4
	Nutrition during adolescence – increased nutrient needs (calcium, iron, protein); eating disorders (anorexia nervosa, bulimia nervosa)		K2, K4
	Nutrition during adulthood and old age – metabolic changes; nutrient needs; common health issues (osteoporosis, sarcopenia); dietary modifications		K2, K4
	Nutrition during pregnancy and lactation – increased energy, protein, iron, folic acid, calcium requirements; foods to avoid; morning sickness, gestational diabetes		K2, K4

Unit 4: Therapeutic Nutrition and Diet Therapy			
Unit -4	Introduction to therapeutic diets – definition of diet therapy; types of modifications (texture, nutrients, frequency); regular, soft, liquid, bland, low-fibre, high-fibre diets		K2, K3
	Diet for diabetes mellitus – types of diabetes (Type 1, Type 2, gestational); role of carbohydrates (glycemic index); meal planning (carbohydrate counting); sugar substitutes		K2, K4
	Diet for cardiovascular diseases – hypertension (low-sodium diet – DASH diet); high cholesterol (low-saturated fat, low-trans fat diet); obesity and weight management		K2, K4
	Diet for gastrointestinal disorders – constipation (high-fibre diet); diarrhea (fluid and electrolyte replacement); peptic ulcer (bland diet); GERD (avoid spicy, fatty foods)		K2, K4
	Diet for kidney and liver diseases – renal diet (low protein, low sodium, low potassium, low phosphorus); liver disease (low protein in advanced stages, avoid alcohol)		K2, K4
Unit 5: Weight Management, Modern and Diets			
Unit -5	Body composition and energy balance – Body Mass Index (BMI) calculation and interpretation; basal metabolic rate (BMR); factors affecting BMR;		K3, K4
	Weight management strategies – weight loss (calorie deficit, portion control, increased physical activity); weight gain (calorie surplus, nutrient-dense foods); fat diets and their risks		K2, K4
	Popular modern diets – intermittent fasting (16:8, 5:2), ketogenic diet (low-carb, high-fat), vegan diet, gluten-free diet, paleo diet – principles, benefits, and limitations		K2, K4
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand basic nutrition concepts and classify macro and micronutrients with their functions and deficiency diseases.

2. Comprehend digestion, absorption, and metabolism, plan a balanced diet using My Plate, and understand RDA and EAR.

3. Grasp nutritional requirements across life stages including infancy, adolescence, old age, and pregnancy, along with deficiencies.

4. Recognize therapeutic diets for diabetes, cardiovascular diseases, GI disorders, kidney and liver diseases, and various diet modifications.

5. Understand BMI and BMR calculation, energy balance, and apply weight management strategies.

6. Appreciate evaluation of popular modern diets such as intermittent fasting, keto, and vegan diets, and debunk common nutrition myths.

Reference Books

1.	Mahan, L. K., & Raymond, J. L. (2020). Krause's food & the nutrition care process (15th ed.). Elsevier.
2.	Ross, A. C., Caballero, B., Cousins, R. J., Tucker, K. L., & Ziegler, T. R. (2020). Modern nutrition in health and disease (12th ed.). Wolters Kluwer.
3.	Stipanuk, M. H., & Caudill, M. A. (2018). Biochemical, physiological, and molecular aspects of human nutrition (4th ed.). Elsevier.
4.	Srilakshmi, B. (2018). Dietetics (8th ed.). New Age International.

Textbooks

5.	Tamil Nadu State Council of Educational Research and Training (SCERT) publishes dedicated Higher Secondary (Classes 11 and 12) textbooks for Nutrition and Dietetics
6.	Food and Nutrition: Principles and Practices for Better Dietary Management, Mahindra Deshpande, Nikhilesh Kulkarni, Himalaya Publishing House.
7.	Mudambi, S. R., & Rajagopal, M. V. (2017). Fundamentals of foods, nutrition and diet therapy (6th ed.). New Age International.
8.	Bamji, M. S., Krishnaswamy, K., & Brahmam, G. N. V. (2019). Textbook of human nutrition (4th ed.). Oxford & IBH Publishing.

Online Resources (Free or Accessible)

9.	**ICMR-NIN – Dietary Guidelines for Indians (2024) Government Guidelines https://www.nin.res.in (Search: Dietary Guidelines)**
10.	**NIH – Dietary Supplements Fact Sheets Educational Database https://ods.od.nih.gov**
11.	**https://www.eatright.org/?utm**
12.	**https://medlineplus.gov/nutrition.html?utm**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average

CO1	3	2	1	1	1	1	2	2	**1.6**
CO2	3	2	1	2	1	2	2	2	**1.9**
CO3	3	2	1	1	1	2	2	2	**1.8**
CO4	3	3	1	2	1	2	3	2	**2.1**
CO5	3	3	2	2	2	2	2	2	**2.3**
CO6	3	3	1	2	2	2	2	3	**2.3**
Average	**3.0**	**2.5**	**1.2**	**1.7**	**1.3**	**1.8**	**2.2**	**2.2**	**2.0**

Final Overall Matrix Score = 2.0/3.00=66.67%

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HUMAN ENDOCRINOLOGY

Non Major Elective-	**Credits:3**	**Paper Code:**
Total Contact Hours:36		**Weekly Contact Hours: 3**

Course Outcomes (COs) for Human Endocrinology

On the successful completion of the course, student will be able to:

	Course Outcome	K Level
CO1	Define endocrinology, classify hormones, and explain the structure and functions of hypothalamus and pituitary gland with associated disorders.	K2, K4
CO2	Describe the structure and functions of thyroid, parathyroid, and pineal glands; explain their disorders.	K2, K4
CO3	Explain the role of pancreas in blood glucose regulation and describe the causes, symptoms, and complications of Diabetes Mellitus.	K2, K4
CO4	Describe the structure and functions of adrenal glands; explain the "fight or flight" response and disorders like Cushing's syndrome and Addison's disease.	K2, K4
CO5	Explain the hormonal regulation of male and female reproductive systems, menstrual cycle, puberty, pregnancy, and menopause.	K2, K4
CO6	Integrate knowledge of endocrine glands to understand common endocrine disorders and their clinical manifestations.	K2, K4

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

Pre-requisite knowledge: Basic biochemistry (synthesis and metabolism of proteins and steroids), mammalian physiology (especially homeostasis)

Unit	Topic Name	Hrs.	K. level
Unit 1: Introduction to Endocrinology and Pituitary Gland			
1	Definition and scope of endocrinology; difference between endocrine and exocrine glands; major endocrine glands of the human body (location and basic function)		K1, K2
	Hormones – definition, chemical nature (steroid, peptide, amine), properties, and general mechanism of action		K1, K2
	Hypothalamus – structure and role as the master regulator; hypothalamic hormones (releasing and inhibiting hormones)		K2, K3
	Pituitary gland (Hypophysis) – location, structure (anterior and posterior lobes), and connections with hypothalamus (hypothalamo-hypophyseal portal system)		K2, K3
	Hormones of anterior pituitary (GH, TSH, ACTH, FSH, LH, Prolactin, MSH) and posterior pituitary (ADH, Oxytocin) – functions and disorders (Dwarfism, Gigantism, Acromegaly, Diabetes Insipidus)		K2, K4
Unit 2: Thyroid, and Parathyroid,			
2	Thyroid gland – location, structure (follicles and follicular cells); (T3 and T4) – role of iodine		K2, K3
	Functions of thyroid hormones (regulation of BMR, growth, development);		K2, K4
	Thyroid disorders – Hypothyroidism (Goiter) and Hyperthyroidism (Graves' disease); clinical features and causes		K2, K4
	Parathyroid glands – location, structure; Parathormone (PTH) – functions in calcium and phosphorus balance		K2, K3
	Disorders of parathyroid – Hypoparathyroidism (Tetany) and Hyperparathyroidism (bone resorption); Calcitonin (from thyroid);		K2, K4
Unit 3: Pancreas and Regulation of Blood Glucose			
3	Pancreas – location, structure (exocrine and endocrine parts); Islets of Langerhans (alpha cells, beta cells, delta cells)		K1, K2
	Insulin secretion, lowering blood glucose; Glucagon – synthesis, secretion, raising blood glucose.		K2, K3
	Diabetes Mellitus (DM) – Type 1 (insulin-dependent) and Type 2 (non-insulin-dependent) – causes, symptoms, Hypoglycemia – causes and symptoms		K2, K4

Unit 4: The Stress Response Glands (Adrenal) – Fight, Fright, and Flight			
4	Adrenal glands – location, structure (cortex and medulla);		K1, K2
	Adrenal medulla – catecholamines (epinephrine and norepinephrine) – release, and actions (fight or flight response)		K2, K3
	Adrenal cortex –hormones (mineralocorticoids, glucocorticoids, androgens)		K2, K4
	Aldosterone (mineralocorticoid) – functions (sodium and water retention, potassium excretion);		K2, K3
	Cortisol (glucocorticoid) – functions (stress response, metabolism, anti-inflammatory); disorders – Cushing's syndrome (excess cortisol) and Addison's disease (cortisol deficiency)		K2, K4
Unit 5: Hormones of Reproduction and Development			
5	Male reproductive system – testes; testosterone – synthesis, functions (spermatogenesis, male secondary sexual characteristics)		K2, K3
	Female reproductive system – ovaries; estrogen and progesterone – synthesis, functions (female secondary sexual characteristics, menstrual cycle)		K2, K3
	Menstrual cycle – hormonal regulation (GnRH, FSH, LH, estrogen, progesterone); phases of menstrual cycle (follicular, ovulatory, luteal)		K2, K4
	Puberty, Menopause, and Pregnancy – hormonal changes during puberty; menopause (causes and symptoms); placental hormones (hCG, estrogen, progesterone) during pregnancy; Disorders of reproductive hormones-– PCOS (Polycystic Ovary Syndrome		K2, K3
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand endocrinology, classify hormones, and comprehend hypothalamus and pituitary structure and functions with associated disorders.
2. Comprehend thyroid, parathyroid, and pineal glands, and understand thyroid hormone synthesis, functions, and disorders.
3. Grasp the role of the pancreas in blood glucose regulation and understand causes and symptoms of diabetes mellitus.
4. Recognize adrenal glands, the fight-or-flight response, aldosterone and cortisol functions, and associated disorders.
5. Understand hormonal regulation of male and female reproductive systems, the menstrual cycle, pregnancy, menopause, and PCOS.
6. Appreciate integration of knowledge of endocrine glands to understand common endocrine disorders and feedback mechanisms.

Reference Books

1.	Melmed, S., Auchus, R. J., Goldfine, A. B., Rosen, C. J., & Kopp, P. (Eds.). (2025). *Williams textbook of endocrinology* (15th ed.). Elsevier
2.	Gardner, D. G., & Shoback, D. (2024). *Greenspan's basic and clinical endocrinology* (11th ed.). McGraw-Hill Education.
3.	McDermott, M. T. (2020). *Endocrine secrets* (7th ed.). Elsevier.
4.	Unnikrishnan, A. G., Bantwal, G., & Kalra, S. (Eds.). (2016). *Clinical methods in endocrinology and diabetology*. Jaypee Brothers Medical Publishers.

Textbooks

5.	Dharmalingam, M. (2010). *Textbook of endocrinology*. Jaypee Brothers Medical Publishers.
6.	Kalra, S., Bantwal, G., Sahay, R., Saboo, B., & Unnikrishnan, A. G. (Eds.). (2021). *ESI textbook of endocrinology* (Vols. 1–2). Jaypee Brothers Medical Publishers
7.	Panchal, S., & Kupesic-Plavsic, S. (Eds.). (2018). *Donald School textbook of human reproductive and gynecological endocrinology*. Jaypee Brothers Medical Publisher
8.	Das, A. K., Sachdev, Y., Bajaj, J. S., & Bajaj, M. (2008). *Special topics in endocrinology* (1st ed.). Jaypee Brothers Medical Publishers
9.	Khardori, R., & Bansal, D. D. (2017). *Introductory endocrinology: A concise and applied digest*. Jaypee Brothers Medical Publisher

Online Resources (Free or Accessible)

10.	**https://www.kenhub.com**
11.	**https://www.coursera.org (Search: Introductory Human Physiology)**
12.	**https://www.khanacademy.org (Search: Endocrine System)**
13.	**https://www.coursera.org (Search: Introductory Human Physiology)**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	2	3	3	2	2	2	**2.38**
CO2	3	2	2	2	2	2	2	2	**2.13**
CO3	3	3	1	2	1	1	3	2	**2.00**
CO4	3	2	1	1	1	1	2	2	**1.63**
CO5	3	2	1	1	1	1	2	2	**1.63**
CO6	3	3	1	2	1	1	3	2	**2.00**
Average	**3.00**	**2.33**	**1.33**	**1.83**	**1.50**	**1.33**	**2.33**	**2.00**	**1.95**

Final Overall Matrix Score = 1.95/3.00=65.28%

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-II

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

HUMAN RIGHTS

Compulsory paper-	**Credits:1**	**Paper Code:**
Total Contact Hours:12		**Weekly Contact Hours: 1**

Refer the Govt. Provided Syllabus

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-III

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

IMMUNOLOGY

Core Paper-07	**Credits:4**	**Paper Code:**
Total Contact Hours:60		**Weekly Contact Hours: 5**

Course Outcomes (COs) for Immunology

On the successful completion of the course, student will be able to:		
COs	**Course Outcome**	**K Level**
CO1	Explain the organization of the immune system, including innate vs. adaptive immunity, immune cells, and primary/secondary lymphoid organs.	**K2, K4**
CO2	Describe antigen-antibody interactions, antibody structure and isotypes, monoclonal antibody production, and the genetic basis of antibody diversity.	**K2, K4**
CO3	Analyze MHC structure, antigen processing pathways (endogenous and exogenous), and the role of APCs in T cell activation.	**K4, K5**
CO4	Explain T cell and B cell development, activation mechanisms, subsets, and effector functions in cell-mediated and humoral immunity.	**K4, K5**
CO5	Classify and analyze hypersensitivity reactions, autoimmunity, immunodeficiencies, and transplantation rejection mechanisms.	**K4, K5**
CO6	Evaluate vaccine types, their mechanisms of action, and immunological principles underlying vaccination and herd immunity.	**K4, K5**

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

Pre-requisite knowledge: A strong foundation in Molecular Biology, Genetics, and Cell Biology with the understanding about immune system and knowledge of how cells produce proteins, divide, and communicate

Uni	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Introduction to the Immune System			
Unit 1	**History of immunology**: Key discoveries (Jenner, Pasteur, Metchnikoff, Ehrlich, Burnet)		**K1, K2**
	Types of immunity: Innate (natural) vs. Adaptive (acquired) – characteristics, components, and differences		**K2, K4**
	Cells of the immune system: Hematopoiesis, lymphoid lineage (B cells, T cells, NK cells), myeloid lineage (macrophages, dendritic cells, neutrophils, eosinophils, basophils, mast cells)		**K2, K3**
	Primary lymphoid organs: Bone marrow and thymus – structure and function		**K2, K3**
	Secondary lymphoid organs: Lymph nodes, spleen, MALT, GALT, BALT – structure and function		**K2, K3**
Unit 2: Antigens, Antibodies, and Antigen-Antibody Interactions			
Unit 2	Antigens: Definition, Types, properties, immunogenicity vs. antigenicity; haptens, adjuvants, epitopes		**K2, K4**
	Immunoglobulin structure: Basic structure (heavy and light chains, variable and constant regions, Fab, Fc), isotypes (IgG, IgM, IgA, IgD, IgE)		**K2, K4**
	Antigen-antibody interactions: Affinity, avidity, cross-reactivity, precipitation, agglutination, neutralization, opsonization		**K2, K4**
	Monoclonal antibodies: Production (hybridoma technology), applications in diagnosis and therapy		**K2, K4**
	Antibody diversity: Genetic basis – V(D)J recombination, class switching, somatic hypermutation		**K4, K5**
Unit 3: Major Histocompatibility Complex (MHC) and Antigen Presentation			
Unit	Major Histocompatibility Complex (MHC): Organization of MHC genes (Class I, Class II,) HLA in humans		**K2, K4**
	MHC restriction and antigen processing pathways: Endogenous pathway (MHC Class I – proteasome, TAP) and exogenous pathway (MHC Class II – endosome, CLIP, HLA-DM)		**K2, K4**
	Antigen presenting cells (APCs): Dendritic cells, macrophages, B cells – role in T		**K2, K4**

-3	cell activation		
	Cross-presentation: Mechanism and immunological significance		**K4, K5**
Unit 4: T Cell and B Cell Mediated Immunity			
Unit -4	cell development and selection: Thymic selection (positive and negative), CD4/CD8 lineage commitment		**K2, K4**
	T cell activation: TCR complex, CD3, co-stimulatory molecules (CD28/B7)		**K4, K5**
	T cell subsets: CD4+ T helper, cytokines, functions; CD8+ cytotoxic T lymphocytes (CTL) – killing mechanisms		**K4, K5**
	B cell development and activation: B cell development in bone marrow (central tolerance); B cell activation – T-dependent vs. T-independent antigens		**K2, K4**
	B cell responses: Affinity maturation, class switching, memory B cells, plasma cells		**K4, K5**
Unit 5: Immune Dysregulation, Hypersensitivity, and Applied Immunology			
Unit -5	Hypersensitivity reactions: Type I (IgE-mediated – anaphylaxis, allergy), Type II (antibody-mediated – hemolytic anemia), Type III (immune complex – serum sickness), Type IV (cell-mediated – contact dermatitis, TB test)		**K2, K4**
	Autoimmunity: Mechanisms (loss of self-tolerance, molecular mimicry, epitope spreading); examples (Rheumatoid arthritis, Type 1 diabetes, SLE)		**K4, K5**
	Immunodeficiency: Primary (genetic – SCID,) and Secondary (HIV/AIDS)		**K4, K5**
	Vaccines: Types (live attenuated, inactivated, subunit, conjugate, mRNA, viral vector); vaccine development principles; herd immunity		**K2, K4**
	Transplantation immunology: Graft types (autograft, isograft, allograft, xenograft); rejection mechanisms (hyperacute, acute, chronic); immunosuppressive therapy		**K2, K4**
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand immune system organization, types of immunity, immune cells, and primary and secondary lymphoid organs.
2. Comprehend antigen-antibody interactions, antibody isotypes, monoclonal antibody production, and the genetic basis of diversity.
3. Grasp MHC structure, antigen processing pathways including endogenous and exogenous routes, and cross-presentation.
4. Recognize T cell and B cell development, activation, subsets, and effector functions such as Th1, Th2, CTL, and plasma cells.
5. Understand hypersensitivity reactions, autoimmunity, immunodeficiencies including HIV/AIDS, and transplantation rejection.
6. Appreciate evaluation of vaccine types including mRNA and viral vector vaccines, their mechanisms of action, and the principle of herd immunity.

Reference Books

1.	Kuby, J. 1997. Immunology. W. H. Freeman & Co., New York,
2.	Male, D. J. Brostoff, D. B. Roth and I. Roitt. 2006. Immunology (7th edition), Mosby / Elsevier, Philadelphia.
3.	Abbas, A. K and A. H. Lichtman. 2007. Cellular and Molecular Immunology (6th edition), W. B. Saunders, Philadelphia,
4.	How the Immune System Works (6th Edition) Lauren M. Sompayrac Wiley
5. Textbooks	
6.	Latha, P. M. (2021). A textbook of immunology (2nd ed.). S. Chand Publishing
7.	Kannan, I. (2019). Immunology. MJP Publishers.4. Basir, S. F. (2012). Textbook of immunology (2nd ed.). PHI Learning.
8.	Basir, S. F. (2012). Textbook of immunology (2nd ed.). PHI Learning.
9.	Mohanty, S. K. (2014). Textbook of immunology. Jaypee Brothers Medical Publishers
10. Online Resources (Free or Accessible)	
11.	**iBiology – Immunology Video Lectures Video Library https://www.ibiology.org (Search: Immunology)**
12.	**Khan Academy – Immunology Video Library https://www.khanacademy.org (Search: Immunology)**
13.	**University of Birmingham – Immunology (Clinical Sciences) Course Materials https://www.birmingham.ac.uk**
14.	**HHMI BioInteractive – Immunology Animations & Videos https://www.biointeractive.org (Search: Immunology)**
15.	**University of British Columbia – Immunology (CAPS 390) Online Course Materials https://www.ubc.ca (Search: CAPS 390 Immunology)**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	1	1	1	1	2	2	**1.6**
CO2	3	2	2	1	1	1	2	2	**1.8**
CO3	3	3	2	2	1	1	3	2	**2.1**
CO4	3	3	2	2	1	1	3	2	**2.1**
CO5	3	3	1	2	1	1	3	2	**2.0**
CO6	3	3	1	2	2	2	3	3	**2.4**
Average	**3.0**	**2.7**	**1.5**	**1.7**	**1.2**	**1.2**	**2.7**	**2.2**	**2.014**

Final Overall Matrix Score = 2.014/3.00=67.13%

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-II

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

BIOSTATISTICS AND BIOINFORMATICS

Core Paper-	**Credits:4**	**Paper Code:**
Total Contact Hours:60		**Weekly Contact Hours: 5**

Course Outcomes (COs) for Biostatistics and Bioinformatics

On the successful completion of the course,studentwill beable to:

COs	Course Outcome	K Level
CO1	Explain the scope of biostatistics, classify biological data, and apply appropriate sampling methods for zoological research.	**K2, K3, K4**
CO2	Calculate and interpret measures of central tendency, dispersion, and probability Correlation and Regression distributions for biological datasets.	**K3, K4**
CO3	Apply hypothesis testing framework, perform t-tests, ANOVA, and chi-square tests to analyze biological data.	**K4, K5**
CO4	Explain Scope and application of Bioinformatics ,acquiring Genomics and Proteomics data (NCBI, GenBank, UniProt), perform BLAST searches,	**K3, K4**
CO5	major biological databases interpret sequence alignment results for understanding evolutionary sequences	**K3, K4**
CO6	Integrate basic biostatistics and bioinformatics approaches to analyze simple biological research problems.	**K5**

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

Pre-requisite knowledge: A strong foundation on blending of biology, mathematics, statistics, and computer science

Unit	Topic Name	Hrs.	K. level
Unit 1: Introduction to Biostatistics and Data Analysis			
Unit 1	Definition, scope, and applications of biostatistics in biological and zoological research		K1, K2
	Types of data: Qualitative (nominal, ordinal) and Quantitative (discrete, continuous)		K2, K3
	Sampling methods: Random, stratified, systematic, cluster sampling – advantages and disadvantages		K2, K4
	Data organization: Frequency distribution, class intervals, cumulative frequency, graphical representation (bar chart, histogram, pie chart, line graph)		K3, K4
	Introduction to statistical software: MS Excel for basic data entry and graphing		K3
Unit 2: Descriptive Statistics			
Unit 2	Measures of central tendency: Mean (arithmetic, geometric), median, mode – calculation for grouped and ungrouped data		K3, K4
	Measures of dispersion: Range, variance, standard deviation, coefficient of variation (CV)		K3, K4
	Probability distributions: Normal distribution (Gaussian), Z-scores, standard normal curve		K2, K3
	Correlation analysis: Pearson's correlation coefficient (r) – calculation, interpretation, and limitations		K3, K4
	Simple linear regression: Regression equation ($Y = a + bx$), slope, intercept, coefficient of determination (R^2)		K3, K4
Unit 3: Inferential Statistics – Hypothesis Testing			
Unit -3	Basic probability concepts: Addition rule, multiplication rule, conditional probability		K2, K3
	Hypothesis testing framework: Null (H_0) and alternative (H_1), Type I error (α), Type II error (β), p-value, significance level		K4, K5
	Student's t-test: One-sample t-test, independent (unpaired) t-test, paired t-test – assumptions and applications		K3, K4
	Analysis of Variance (ANOVA): One-way ANOVA		K4, K5
	Chi-square test: Goodness-of-fit and test of independence (contingency tables)		K3, K4

Unit 4: Basic Bioinformatics – Databases And sequences			
Unit -4	Introduction to bioinformatics: Definition, scope, and applications in zoology, genomics, Proteomics and evolutionary biology		K1, K2
	Biological databases: Primary, Secondary and Derived		K1, K2
	Data base Search: Primaryandsecondary data base search Sequence file formats: FASTA, FASTQ, GenBank format – structure and usage		K2, K3
Unit 5: Sequence Analysis, and Phylogenetics			
Unit -5	Sequence alignment: Local, global, Pair wise, Multiple Scoring matrices, PAM, BLOSUM		K3, K4
	BLAST: Types (blastn, blastp, blastx, tblastn, tblastx) – interpretation of results,		K3, K4
	Phylogenetic analysis basics: Distance-based methods (**UPGMA**, Neighbor-Joining) and character-based methods (Maximum Parsimony, Maximum Likelihood) – concepts only		K2, K4

On the successful completion of the course the Learning Outcomes are

1. Understand the scope of biostatistics, classify biological data, and apply appropriate sampling methods.
2. Comprehend measures of central tendency, dispersion, correlation using Pearson's r, and linear regression.
3. Grasp hypothesis testing including t-test, ANOVA, and chi-square, and interpret p-values and significance levels.
4. Recognize the scope of bioinformatics, navigate NCBI, GenBank, and UniProt, and differentiate database types.
5. Understand sequence alignment using BLAST, grasp scoring matrices like PAM and BLOSUM, and interpret results.
6. Appreciate integration of biostatistics and bioinformatics to analyze biological problems including basic phylogenetic analysis.

Reference Books

1.	Sokal, R.R. and F.J. Rohlf. 1981. Biometry: The principles and practice of statistics in biological research, San Francisco:W.H. Freeman, London
2.	Zar,J.H. 1998. Biostatistical Analysis, Pearson Education (Singapore)Pvt. Ltd., Delhi, India,
3.	Bailey,N.T.J.1994.StatisticalMethodsinBiology(ThirdEdition),Cambridge University Press, Cambridge
4.	WayneW.Daniel.Biostatistics:AFoundationforAnalysisintheHealthSciences, John Wiley & Sons Inc, USA

Textbooks

5.	Arora,P.N.andP.K.Malhan1996.Biostatistics,HimalayaPublishingHouse, Mumbai
6.	Gurumani,N2005. IntroductiontoBiostatistics,M.J.P.Publishers,Delhi
7.	Das, D. and A. Das2004. Academic Statistics in Biology and Psychology, Academic Publisher, Kolkata
8.	Palanichamy,S.andManoharan,M1990.StatisticalMethodsforBiologists,Palani Paramount Publications, Tamil Nadu,

Online Resources (Free or Accessible)

9.	**NPTEL – Biostatistics and Bioinformatics (MZC-006) Free Online Courselhttps://nptel.ac.in (Search: Biostatistics and Bioinformatics)**
10.	**Khan Academy – Statistics and ProbabilityVideo Libraryhttps://www.khanacademy.org/math/statistics-probability**
11.	**NCBI – BLAST and Sequence Analysis Tutorials Interactive Tutorialshttps://www.ncbi.nlm.nih.gov/education/**
12.	**EBI Training – EMBL-EBI Online CoursesFree Courseshttps://www.ebi.ac.uk/training/online**
13.	**Rosalind – Bioinformatics Problem SolvingInteractive Problemshttp://rosalind.info**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	1	3	1	2	1	2	**1.9**
CO2	3	3	2	2	2	1	2	2	**2.1**
CO3	3	3	1	3	3	1	2	2	**2.3**
CO4	3	3	1	3	3	1	2	2	**2.3**
CO5	3	2	1	2	3	1	3	2	**2.1**
CO6	3	3	2	3	3	2	3	3	**2.8**
Average	**3.0**	**2.7**	**1.3**	**2.7**	**2.5**	**1.3**	**2.2**	**2.2**	**2.24**

Final Overall Matrix Score = 2.24/3.00=74.66%

பெரியார் பல்கலைக்கழகம்
PERIYAR UNIVERSITY
DEPARTMENT OF ZOOLOGY
Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-II

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

DEVELOPMENTAL BIOLOGY

Core Paper-	**Credits:4**	**Paper Code:**
Total Contact Hours:60		**Weekly Contact Hours: 5**

Course Outcomes (COs) for Developmental Biology

On the successful completion of the course,studentwill beable to:		
COs	**Course Outcome**	**K Level**
CO1	Explain the history, scope, and model organisms of developmental biology; describe gametogenesis (spermatogenesis and oogenesis) with hormonal regulation; and explain fertilization events including acrosome reaction, cortical reaction, and prevention of polyspermy.	K2, K4
CO2	Compare cleavage patterns (holoblastic vs. meroblastic, radial vs. spiral, determinate vs. indeterminate) across species; describe blastulation and types of blastula; analyze gastrulation processes in frog and chick; and construct simple fate maps.	K4, K5
CO3	Explain neural crest cell migration and derivatives, organogenesis of kidney (pronephros, mesonephros, metanephros), limb development (role of AER and ZPA in patterning), and vulva formation in C. elegans.	K2, K4
CO4	Explain morphogenetic gradients and gradient theory; differentiate types of stem cells (totipotent, pluripotent, multipotent, unipotent); and analyze axis formation in Drosophila, amphibians, and chick including the Spemann-Mangold organizer.	K4, K5
CO5	Explain regeneration types (epimorphosis, morphallaxis, compensatory regeneration); describe aging and senescence (telomere theory); explain metamorphosis in frog (hormonal control) and endocrine control of molting in crustaceans and insects.	K2, K4
CO6	Integrate knowledge of cryopreservation of gametes/embryos and regenerative medicine to understand applications of developmental biology in health and conservation.	K4, K5

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

Pre-requisite knowledge: Require a strong foundation in four core biological disciplines: cell biology, genetics, molecular biology, and biochemistry

Unit	Topic Name	Hrs.	K. level
Unit 1: History, scope, gametogenesis, fertilization			
Unit 1	Definition, history and scope of developmental biology; models of development		K1, K2
	Gametogenesis – Spermatogenesis: spermiogenesis; hormonal regulation (FSH, LH, testosterone)		K2, K4
	Oogenesis: hormonal regulation (FSH, LH, estrogen, progesterone)		K2, K4
	Fertilization – external vs. internal fertilization; sperm capacitation and acrosome reaction; egg activation and cortical reaction (prevention of polyspermy); fusion of pronuclei; calcium wave activation		K2, K4
Unit 2: Cleavage, blastulation, gastrulation, fate maps			
Unit 2	Cleavage – types of cleavage (holoblastic vs. meroblastic; radial vs. spiral; indeterminate vs. determinate); patterns in frog, chick		K2, K4
	Blastulation – formation of blastula; blastocoel; types of blastula (coeloblastula, discoblastula, blastocyst in mammals); inner cell mass vs. trophoblast		K2, K4
	Gastrulation – morphogenetic movements (formation of germ layers and derivatives (ectoderm, mesoderm, endoderm); gastrulation in frog (yolk plug, blastopore), chick (primitive streak, Hensen's node		K4, K5
	Fate maps – construction of fate maps; vital dye staining (Vogt, 1929); fate map of frog		K4, K5
Unit 3: Organogenesis (kidney, limb, vulva), neural crest			
Unit -3	Neural crest cell migration and derivatives; differentiation of neurons,eye lens induction		K2, K4
	Organogenesis of kidney –kidney development (pronephros, mesonephros, metanephros)		K2, K4
	Limb development – formation of limb buds; apical ectodermal ridge (AER) and its role in outgrowth; zone of polarizing activity (ZPA) and patterning (Shh signaling); proximal-distal, anterior-posterior, dorsal-ventral axes		K4, K5

	Vulva formation in *Caenorhabditis elegans*		K4, K5
Unit 4: Gradients, stem cells, axis formation, Spemann organizer			
Unit -4	Morphogenetic gradients and gradient theory; cell fate and cell lineages; cytoplasmic determinants;		K2, K4
	Cell differentiation and stem cells – mechanisms of differentiation, types of stem cells (totipotent, pluripotent, multipotent, unipotent); embryonic stem cells (ESCs), adult stem cells, induced pluripotent stem cells (iPSCs),Extra embryonic membranes		K2, K4
	Axis formation in Drosophila, amphibia and chick– establishment of body axes (anterior-posterior, dorsal-ventral, left-right); Spemann-Mangold organizer (primary organizer in amphibians);		K4, K5
Unit 5: Regeneration, aging, metamorphosis, molting and Cryopreservation of germ cell and embryo,			
Unit -5	Regeneration – epimorphosis (limb regeneration in planaria, morphallaxis; compensatory regeneration (liver regeneration in mammals);		K4, K5
	Aging and senescence – cellular senescence (telomere shortening, replicative senescence);		K2, K4
	Metamorphosis in frog-Hormonal control and development;Endocrine control of moulting in crustaceans and insects;		K4, K5
	Cryopreservation of gametes/embryos.		K2,K3
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand gametogenesis with hormonal regulation and fertilization events including acrosome reaction and calcium wave.

2. Comprehend cleavage patterns, blastulation, gastrulation in frog and chick, and construct simple fate maps.

3. Grasp neural crest derivatives, organogenesis of kidney, limb development involving AER and ZPA, and vulva formation in C. elegans.

4. Recognize morphogenetic gradients, stem cell types, axis formation with Spemann-Mangold organizer, and extraembryonic membranes.

5. Understand regeneration types, aging and senescence, metamorphosis in frog, and endocrine control of molting.

6. Appreciate integration of cryopreservation of gametes and embryos with regenerative medicine for health and conservation

Reference Books

1.	Barresi, M. J. F., & Gilbert, S. F. (2023). Developmental biology (13th ed.). Oxford University Press.
2.	Slack J.M.W. 2012. Essential Developmental Biology(3rd Edition), Wily-Blackwell Publications, USA,
3.	Berrill,N.J.1974. DevelopmentalBiology,TataMc-GrawHillPublications,New Delhi,
4.	Müller, W. A. (1997). Developmental biology. Springer.
	5. Textbooks
6.	Balinsky, B. I. 1981. Introduction to Embryology (5th Edition), CBS College Publishers, New York,
7.	Gilbert, S. F. (2013). Developmental biology (10th ed.). Sinauer Associates.
8.	Tyler, M.S. 2000. Developmental Biology - A Guide for Experimental Study, Sunderland, MA,
9.	Subramoniam,T.2011.MolecularDevelopmentalBiology(2nd Edition),Narosa Publishers, India,
	10. Online Resources (Free or Accessible)
11.	https://www.ncbi.nlm.nih.gov/books/?utm
12.	**Society for Developmental Biology Resource URL: https://sdbcore.org/**
13.	**https://preview.global.oup.com/academic/product/wolperts-principles-of-development-9780192896612**
14.	**The Company of Biologists Resource URL: https://thenode.biologists.com/**
15.	**https://embryology.med.unsw.edu.au/embryology/index.php/Main_Page**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	3	3	3	3	2	2	**2.63**
CO2	3	3	2	2	1	2	1	2	**2.00**
CO3	3	2	2	1	1	2	2	2	**1.88**
CO4	3	3	2	2	2	1	2	2	**2.13**
CO5	3	2	1	1	1	2	2	2	**1.75**
CO6	3	2	2	2	1	2	2	2	**2.00**
Average	**3.00**	**2.33**	**2.00**	**1.83**	**1.50**	**2.00**	**1.83**	**2.00**	**2.057**

Final Overall Matrix Score = 2.057/3.00=68.57%

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PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

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M.Sc. Zoology Course - SEMESTER-III

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

LAB COURSE III

Immunology, Biostatistics & Bioinformatics, Developmental Biology

Core practical -	**Credits:2**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

COURSE OUTCOMES (COs)

Course Outcome	Description	K Level
CO1	Identify and classify blood cells, lymphoid tissues, developmental stages of frog and chick, and primary biological tools/databases based on structural and functional characteristics.	**K1, K2**
CO2	Perform hematological and immunological techniques (differential & total leukocyte counts, blood smear preparation) to identify cellular components and diagnostic states.	**K3**
CO3	Analyze and interpret statistical outputs (t-test, ANOVA, chi-square, regression) and molecular models (antibody structures, MHC complexes) to draw biological inferences.	**K4**
CO4	Perform biostatistical calculations (measures of central tendency, dispersion, correlation) and generate standard curves for quantitative estimations using biological data.	**K3, K4**
CO5	Apply bioinformatics tools and databases (NCBI, GenBank, BLAST, ClustalW, MEGA) for sequence retrieval, alignment, and molecular phylogenetic analysis.	**K4, K5**
CO6	Demonstrate proficiency in operating laboratory software, interpreting statistical graphs, and maintaining proper scientific practical records, diagrams, and reports.	**K3, K5**

SECTION A – MAJOR PRACTICALS

S.No.	Practical Title	Organism / Material	Key Observation Points	Evaluation Basis
1	Differential Leukocyte Count (DLC) – Identification of WBCs	Human Blood Smear	Prepare blood smear; stain with Leishman's/Wright's stain; identify and count 100 WBCs (neutrophils, lymphocytes, eosinophils, basophils, monocytes); calculate percentage of each cell type.	Smear Quality + Staining + Identification + Calculation & Result
2	Total Leukocyte Count (TLC) using Hemocytometer	Human Blood Sample	Dilute blood with Turk's fluid (lyses RBCs, stains WBC nuclei); charge Neubauer chamber; count cells in 4 large corner squares; calculate total count per mm^3 using dilution and depth factors.	Procedure + Chamber Charging + Counting Accuracy + Formula & Calculation
3	Biostatistical Computation: Mean, Median, Mode, Standard Deviation, and Variance	Biological Datasets (e.g., student height, animal weight, glucose levels)	Calculate central tendency (mean, median, mode) and dispersion metrics (variance, standard deviation) from raw biological data; interpret data distribution.	Formulae + Step-by-step Calculation + Statistical Interpretation
4	Hypothesis Testing: Student's t-test (Paired and Independent)	Biological / Medical Case Data	Perform independent t-test (control vs treatment) or paired t-test (before vs after treatment); calculate t-statistic; compare with critical table	Hypothesis Formulation + Calculation + Critical Value

			values; interpret p-value significance ($p < 0.05$).	Comparison + P-value Interpretation
5	Correlation Analysis from Biological Metrics	Biological Data Pairs (e.g., Height/Weight, Leaf Length/Breadth, Fish Length/Weight)	Calculate Pearson's correlation coefficient (r) or Spearman's rank correlation; determine direction and strength of relationship between variables; interpret biological significance.	Data Tabulation + Formula Application + R-value Calculation + Biological Inference
6	Comparative Study of Avian Embryonic Development	*Gallus gallus* (Chick Embryos)	Observe prepared whole mount slides of 24h (primitive streak, Hensen's node), 48h (neural tube, 10–12 somites, tubular heart), 72h (optic cups, limb buds, heart chambers), and 96h (membranes, beak, digits) chick embryos.	Identification of Stage + Detailed Labelled Diagram + Morphological Description

SECTION B – MINOR PRACTICALS

S.No.	Practical Title	Type / System	Points to Study
1	Mounting of Blood Smear and Differential Staining	Permanent slide / temporary mount	Prepare thin blood smear; fix with methanol; stain with Leishman's stain (eosin-methylene blue complex); observe and differentiate RBCs, WBC types, and platelets under high power.
2	Preparation of Standard Calibration Curve for Protein Estimation	Biochemistry / MS Excel	Prepare BSA standard solutions (0.2–1.0 mg/mL); perform Bradford or Lowry assay; measure absorbance; plot absorbance vs. concentration in MS Excel; fit a linear regression trendline; generate R^2 equation.
3	Measures of Central Tendency, Dispersion, and Regression using Excel	Biostatistics / MS Excel	Use Excel formulas to calculate mean, SD, and Pearson's r; execute simple linear regression ($Y = a + bx$); extract slope (b), intercept (a), and coefficient of determination (R^2); predict Y from X.
4	Observation of Early Chick Embryo - Gastrulation Stage	Whole Mount Slide (24 Hours)	Identify primitive streak (thickened line), Hensen's node (primitive knot), primitive groove, epiblast, and hypoblast layers. Relate structures to avian gastrulation and germ layer formation.

SECTION C – SPOTTERS (Slides, Charts, Instruments & Outputs)

S.No.	Specimen / Organism / Component	Material Type	Points to Observe & Biological Significance
1.	Blood Smear (Leishman stained)	Stained Slide	Identify WBC types: Neutrophils (2-5 lobes, pink granules), Lymphocytes (large nucleus, thin blue cytoplasm), Eosinophils (bilobed, red granules), Basophils (blue granules), Monocytes (kidney nucleus). Note phagocytic and adaptive roles.
2.	Lymph Node (T.S.)	Histological Slide	Observe outer cortex with lymphoid follicles (germinal centers), inner medulla with medullary cords, capsule, and subcapsular sinus. Primary site of lymph filtration and B cell activation.
3.	Spleen (T.S.)	Histological	Differentiate white pulp (periarteriolar lymphoid sheath -

		Slide	PALS) and red pulp (splenic sinusoids filled with RBCs) enclosed in a fibrous capsule. Filters blood and eliminates aged erythrocytes.
4.	Thymus (T.S.)	Histological Slide	Observe lobules divided into a dense cortex (tightly packed immature thymocytes) and a pale medulla containing characteristic Hassall's corpuscles. Site of T-cell maturation and selection.
5.	Bone Marrow (T.S.)	Histological Slide	Identify highly cellular hematopoietic tissue containing myeloid and lymphoid precursor cells, large megakaryocytes (platelet precursors), and interspersed adipocytes. Site of hematopoiesis.
6.	ELISA Plate with Color Change	Immunological Kit/Picture	96-well microtiter plate displaying yellow-to-blue color transitions post-TMB substrate addition. Positive wells indicate antigen/antibody presence. Applied in HIV, COVID-19, and pregnancy screening.
7.	WIDAL Test Tube Agglutination	Picture	Observe visible clumps/agglutinates at the tube bottom with a clear supernatant fluid. Used for typhoid fever diagnosis; detects specific antibodies against Salmonella typhi O and H antigens.
8.	Rapid Antigen Test Card	Picture	Lateral flow immunoassay plastic cassette containing sample pad, conjugate pad, and nitrocellulose membrane showing control (C) and test (T) bands. Used for point-of-care diagnosis (e.g., COVID-19).
9.	Ouchterlony Double Diffusion Plate	Picture	Observe distinct opaque white precipitin bands forming in the agar matrix between antigen and antibody wells. Identifies immunological relationships: identity, partial identity, or non-identity.
10.	Antibody Structure Chart	Molecular Model/Chart	Examine the classic Y-shaped immunoglobulin molecule consisting of 4 polypeptide chains (2 heavy, 2 light), connected by disulfide bonds. Note antigen-binding variable regions (Fab) and effector constant region (Fc).
11.	MHC Class I & Class II Diagram	Molecular Model/Chart	Compare structural domains: Class I (α1, α2, α3 domains non-covalently linked with β2-microglobulin; presents endogenous antigens to CD8+ cells). Class II (α and β chains; presents exogenous antigens to CD4+ cells).
12.	Monoclonal Antibody Production	Flowchart/Model	Review Hybridoma Technology steps: immunization, fusion of splenic B cells with malignant myeloma cells, selection on HAT medium, screening via ELISA, cloning, and expansion to produce identical epitope-specific antibodies.
13.	Histogram Chart	Statistical Plot	Graphical plot featuring adjacent bars representing continuous frequency distributions across defined class intervals. Used to visualize biological continuous variables (e.g., blood pressure, age distribution).
14.	Grouped Bar Chart	Statistical Plot	Graphical plot featuring distinct, separated bars grouped by category. Ideal for comparing discrete qualitative or categorical biological variables across different experimental groups.
15.	Scatter Plot	Statistical Plot	Coordinate plot displaying pairs of data points across an X-independent and Y-dependent axis. Used to visually

			identify positive, negative, or zero linear correlation between two continuous biological variables.
16.	Normal Distribution Curve	Statistical Model	Symmetrical bell-shaped distribution curve centered around the population mean. Follows the standard 68-95-99.7 empirical rule across 1, 2, and 3 standard deviations from the mean (e.g., height, weight data).
17.	ANOVA Table Printout	SPSS / R Printout	Review One-Way Analysis of Variance summary sheets featuring Sum of Squares (SS), degrees of freedom (df), Mean Squares (MS), F-ratio, and p-value. Compares means of three or more experimental groups simultaneously.
18.	Chi-Square Test Output	Contingency Table	Observe categorical contingency tables detailing observed vs. expected frequencies, χ^2 value, df, and p-value. Evaluates the statistical association or independence between two categorical variables.
19.	Pearson's Correlation Output	Software Matrix	Examine mathematical correlation matrices showing Pearson's coefficient (r) ranging from −1.0 to +1.0 and associated p-values. Quantifies the linear strength and direction between continuous variables.
20.	NCBI Homepage Interface	Bioinformatics Screen	Digital gateway displaying cross-database search boxes including PubMed, Nucleotide, Protein, GenBank, and Entrez systems. Primary repository for biomedical literature and genomic datasets.
21.	GenBank Entry Format	Annotated Text File	Examine structured flatfile lines displaying explicit fields: LOCUS (accession/length), DEFINITION, ACCESSION, ORGANISM, FEATURES (genes, coding sequences - CDS), and the raw nucleotide sequence (ORIGIN).
22.	FASTA Sequence Format	Standard Text File	Observe the universal text-based biological sequence structure starting with a single greater-than character ('>') containing header metadata, followed by standard single-letter nucleotide or amino acid codes.
23.	BLAST Alignment Results Page	Bioinformatics Screen	Analyze sequence similarity hit reports detailing query sequence, subject hit alignment matches (|), mismatches, gaps (−), bit scores, query coverage percentage, and statistical Expect values (E-value).
24.	Multiple Sequence Alignment	ClustalW Text Output	Observe parallel stacked sequences with alignment annotations: asterisks (*) signify fully identical residues; colons (:) indicate highly conservative mutations; periods (.) denote semi-conservative changes.
25.	Phylogenetic Tree (Neighbor-Joining)	Molecular Dendrogram	Examine evolutionary branching diagrams displaying clades/branches, nodes representing common ancestors, branch lengths corresponding to evolutionary distance (scale bar), and statistical bootstrap values.
26.	R Software GUI Interface	Statistical Software	Digital interface display layout featuring interactive command console window, script code editor, workspace environment variables tracker, and graphical output/plots layout window.
27.	MEGA Software Interface	Bioinformatics Software	Molecular Evolutionary Genetics Analysis toolkit workspace showing interactive menus for alignment explorer, phylogenetic reconstruction algorithms, sequence viewers, and tree builders.

28.	Frog Embryo - Cleavage Stages	Embryological Slide	Observe equal holoblastic cell divisions showing distinct blastomeres and cleavage furrows progressing from 2-cell, 4-cell, to 8-cell stages without overall embryonic volume growth.
29.	Frog Morula Stage	Embryological Slide	Observe a solid, compact spherical cluster of 16 to 32 blastomeres prior to fluid cavity formation. Characterized by cell compaction and absent blastocoel cavity.
30.	Frog Blastula Stage	Embryological Slide	Identify a hollow spherical embryological stage composed of an outer blastoderm epithelial layer surrounding an internal fluid-filled eccentric cavity called the blastocoel.
31.	Frog Gastrula (Yolk Plug Stage)	Embryological Slide	Observe key morphogenetic movements: blastopore formation via cell invagination, expanding archenteron cavity, and a prominent circular yolk plug protruding at the blastopore mouth. Establishes 3 germ layers.
32.	Frog Neurula Stage	Embryological Slide	Observe early organogenesis showing visible thick neural plate boundaries, elevating neural folds enclosing the developing neural tube, an underlying supportive notochord, and compressed archenteron.
33.	Chick Embryo Whole Mount (24 Hours)	Embryological Slide	Observe avian gastrulation landmarks: elongated primitive streak forming the rostro-caudal axis, primitive groove, terminal Hensen's node organizer, and peripheral area opaca vs. translucent area pellucida.
34.	Chick Embryo Whole Mount (48 Hours)	Embryological Slide	Observe closing anterior neural tube, segmented paired somite blocks (10-12 pairs), an early flexing S-shaped tubular heart, and radiating vitelline blood island networks.
35.	Chick Embryo Whole Mount (72 Hours)	Embryological Slide	Identify advanced organogenesis markers: invaginated optic cups (eye vesicles), distinct forelimb and hindlimb buds, multi-chambered beating heart (atria, ventricles), allantois pocket, and clear amnion.
36.	Chick Embryo Whole Mount (96 Hours)	Embryological Slide	Identify terminal embryonic specialization: explicit avian beak formation, distinct digit indentations on limb buds, vastly expanded vascularized chorioallantoic membrane (CAM), and distinct dermal feather rudiments.

LO No.	Learning Outcome	Related CO	Bloom's Level
LO1	Identify and classify blood cells (WBC types), lymphoid tissues (lymph node, spleen, thymus, bone marrow), immunological assay outputs (ELISA, WIDAL, Ouchterlony, Rapid Antigen Test), statistical plots (histogram, bar chart, scatter plot, normal distribution), bioinformatics formats (FASTA, GenBank), and embryonic stages (frog: cleavage to neurula; chick: 24h to 96h) from slides, charts, and printouts.	**CO1**	K1, K2
LO2	Perform total leukocyte count (TLC) using a hemocytometer and differential leukocyte count (DLC) by preparing, staining (Leishman's/Wright's), and observing thin blood smears to identify neutrophils, lymphocytes, eosinophils, basophils, and monocytes.	**CO2**	K3
LO3	Analyze the structural organization of immunoglobulins (antibody Y-shaped structure with Fab and Fc regions), MHC Class I and Class II molecules, hybridoma technology for monoclonal antibody production, and compare developmental mechanics across amphibian (frog) and avian (chick) embryonic models.	**CO3**	K4
LO4	Calculate and interpret descriptive statistics (mean, median, mode, variance, standard deviation) from biological datasets and perform hypothesis testing using Student's t-test (paired and independent) to compare group means with p-value interpretation.	**CO4**	K3, K4
LO5	Compute Pearson's correlation coefficient (r) to determine the strength and direction of relationships between biological variables, perform Chi-square (χ^2) analysis for	**CO5**	K3, K4

	categorical data association, and interpret ANOVA outputs (F-ratio, p-value) for comparing multiple groups.		
LO6	Generate standard protein calibration curves in MS Excel (Bradford/Lowry assay), perform linear regression (Y = a + bx) with R^2 interpretation, retrieve sequences from NCBI/GenBank, execute BLAST searches for sequence similarity, perform multiple sequence alignment using ClustalW, and reconstruct phylogenetic trees using MEGA software.	**CO6**	K3, K4

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

LO No.	Learning Outcome (Abbreviated)	CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Avg.**
LO1	Identify blood cells, tissues, assays, plots, formats, embryos	CO1	3	2	2	2	1	1	2	2	**1.88**
LO2	Perform TLC, DLC, and blood smear staining	CO2	3	2	3	3	2	2	2	2	**2.38**
LO3	Analyze Ig structure, MHC, and development	CO3	3	3	2	2	1	1	2	2	**2.00**
LO4	Descriptive stats, t-test, and interpretation	CO4	3	3	3	3	1	1	3	3	**2.50**
LO5	Correlation, Chi-square, ANOVA	CO5	3	3	3	3	1	1	3	3	**2.50**
LO6	Calibration curves, BLAST, ClustalW, MEGA	CO5	3	3	3	3	1	1	3	3	**2.50**
	Average		**3.00**	**2.67**	**2.67**	**2.67**	**1.17**	**1.17**	**2.50**	**2.50**	**2.29**

Final Overall Matrix Score = 2.29 / 3.0 (76.3%)

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-III

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

POULTRY FARMING

Elective Paper-	**Credits:3**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

Course Outcomes (COs) for POULTRY SCIENCE

On the successful completion of the course, student will be able to:

COs	**Course Outcome**	**K Level**
CO1	Explain the scope and status of poultry industry in India and Tamil Nadu, principles of poultry housing, and systems of poultry farming.	**K2, K4**
CO2	Classify poultry breeds, explain incubation and hatching methods, describe brooding and rearing techniques, and manage layers and broilers.	**K3, K4**
CO3	Describe nutrient requirements of poultry, identify feed ingredients, formulate rations, and calculate feed conversion ratio.	**K3, K4**
CO4	Identify common poultry diseases (viral, bacterial, fungal, parasitic), explain symptoms and prevention, and prepare vaccination schedules.	**K2, K4**
CO5	Select and handle hatching eggs, perform egg testing, and develop value-added poultry products.	**K3, K5**
CO6	Calculate economics of poultry farming (cost of production, break-even analysis, BCR) and identify marketing channels and government schemes.	**K3, K4**

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

Pre-requisite knowledge: A knowledge of avian anatomy and physiology, basic nutrition and biochemistry, biosecurity and disease control, and genetics

Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Introduction to Poultry Industry and Housing			
Unit 1	Definition and introduction to poultry Present scenario of poultry industry in Tamil Nadu – major poultry hubs (Namakkal – Egg Capital of India, Coimbatore, Salem, Erode)		K1, K2
	Principles of poultry housing – location, orientation, ventilation, lighting, space requirements, litter management, sanitation		K2, K3
	Types of poultry houses – brooder house, grower house, layer house, broiler house; Systems of poultry farming – free range, semi-intensive, intensive (battery cage, deep litter)		K2, K4
	Farm and water hygiene – importance of clean water, waterers (nipple, trough), cleaning and disinfection protocols		K2, K3
Unit 2: Poultry Breeds, Incubation, Brooding, and Management			
Unit 2	Classification of poultry birds – layers (egg production), broilers (meat production), dual-purpose breeds		K2, K4
	Important poultry breeds – Indian breeds (Aseel, Kadaknath, Ghagus, Chittagong); exotic breeds (White Leghorn, Rhode Island Red, New Hampshire, Plymouth Rock); improved varieties (Giriraja, Gramapriya, Vanaraja)		K1, K2
	Methods of hatching – natural incubation (broody hen) vs. artificial incubation (incubator); types of incubators (setter, hatcher); incubation requirements		K3, K4
	Brooding and rearing – types of brooders (gas, electric, infrared); brooder temperature schedule ; brooder guard; chick feeding and watering		K3, K4
	Sexing of chicks – vent sexing (Japanese method), feather sexing (slow vs. fast feathering), Management of broilers and layers – feeding schedule, lighting program, debeaking (ages and methods), vaccination schedule		K3, K4
Unit 3: Poultry Feed Management and Nutrition			
	Principles of feeding – nutrient requirements of poultry		K2, K4
	Nutrient requirements for different stages – pre-starter (0-2 weeks), starter (2-6 weeks), grower (6-18 weeks), layer (18+ weeks), broiler finisher (4-6 weeks)		K2, K4
	Feed ingredients – energy sources (maize, sorghum, millets, broken rice, wheat		K2, K3

Unit -3	bran), protein sources (soybean meal, groundnut cake, fish meal, meat cum bone meal), mineral and vitamin supplements		
	Feed formulation – principles of ration formulation (Pearson square method); types of feed (mash, crumble, pellet); feed additives – growth promoters, coccidiostats, probiotics, prebiotics, enzymes, toxin binders feed conversion ratio (FCR) – calculation and significance		K3, K4
Unit 4: Poultry Diseases and Health Management			
Unit -4	Viral diseases – Ranikhet (Newcastle Disease) – symptoms, prevention, vaccination; Marek's Disease – symptoms, prevention; symptoms, prevention; Avian Influenza (Bird Flu) – symptoms, control measures		K2, K4
	Bacterial diseases – Salmonellosis (Pullorum) – symptoms, control; Fowl Cholera (Pasteurellosis); Mycoplasmosis (CRD) – symptoms, control		K2, K4
	Fungal diseases – Aspergillosis (brooder pneumonia) – causes, symptoms, prevention		K2, K3
	Parasitic diseases – Coccidiosis (Eimeria species) – symptoms, prevention, treatment (coccidiostats in feed); symptoms, control		K2, K4
	Disease management – bio-security in poultry farm (foot bath, vehicle disinfection, restricted entry, all-in-all-out system, dead bird disposal); disinfection methods; quarantine protocol		K2, K3
Unit 5: Egg Production, Value Added Products, and Economics			
Unit -5	Selection, care and handling of hatching eggs – egg collection, cleaning, storage,egg holding period		K3, K4
	Egg testing – candling (fertile vs. infertile eggs, dead germ, cracked eggs); egg quality parameters		K3, K4
	Value added poultry products – egg powder (spray drying, freeze drying), frozen egg products, processing methods		K3, K5
	Economics of poultry farming – capital investment (land, building, equipment, birds), recurring costs (feed, chicks, medicines, labour, electricity, water), income; Profit calculation –; break-even analysis		K3, K4
	Marketing of poultry products – market channels (farm gate, wholesale, retail, supermarkets, online), pricing strategies, government schemes		K2, K4
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand the scope of the poultry industry in India and Tamil Nadu, housing principles, farming systems, and hygiene.

2. Comprehend poultry breeds including layers, broilers, and Indian and exotic breeds, and understand incubation, brooding, rearing, and sexing.

3. Grasp nutrient requirements, identify feed ingredients, formulate rations using the Pearson square method, and calculate FCR.

4. Recognize common viral, bacterial, fungal, and parasitic diseases, understand symptoms and prevention, and prepare vaccination schedules.

5. Understand selection and handling of hatching eggs, perform candling, assess egg quality parameters, and develop value-added products.

6. Appreciate the economics of poultry farming, identify marketing channels, and list government schemes.

Reference Books

1.	Bell, D. D., & Weaver, W. D. (Eds.). (2002). Commercial chicken meat and egg production (5th ed.). Springer.
2.	Small Poultry Farmer – Training Manual NSDC India, NSDC / Ministry of Skill Development
3.	Singh, D. K., & Ali, I. (2014). Hand book of poultry husbandry. International Book Distributing Company.
4.	Vegad, J. L. (2018). Poultry diseases: A guide for farmers and poultry professionals (2nd ed.). International Book Distributing Company.
5.	Poultry Nutrition (3rd Edition) Steven Leeson & John D. Summers University Books
	Textbooks
6.	Sreenivasaiah., P. V., 2015. Textbook of Poultry Science. 1st Edition. Write & Print Publications, New Delhi 2.
7.	Singh, R. P. (2012). A textbook of poultry science. International Book Distributing Co.
8.	Jagdish Prasad. (2020). Handbook of poultry production and management (3rd ed.). Vikas Publishing House.

9.	Ghosh, N. (2023). Poultry science and practice: A textbook. CBS Publishers and Distributors
Online Resources (Free or Accessible)	
10.	**Poultry Farmer Training Manual (NSDC) Training Manual https://nsdcindia.org/sites/default/files/MC_AGR-Q4306_Small-poultry-farmer-.pdf**
11.	**AgMOOC – Treatment of Parasitic Diseases in Livestock and Poultry Free Online Course https://www.col.org (AgMOOC section)**
12.	**e-Courses on Poultry Farming (ICAR – e-Course) Free Online Course http://ecoursesonline.iasri.res.in/course/view.php?id=335**
13.	**Tamil Nadu Veterinary and Animal Sciences University (TANUVAS) University Portal https://tanuvas.ac.in**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	2	1	1	1	1	2	**1.6**
CO2	3	3	3	2	1	1	1	2	**2.0**
CO3	3	3	2	2	1	1	2	2	**2.0**
CO4	3	3	2	2	1	2	3	2	**2.3**
CO5	3	2	2	2	1	1	1	2	**1.8**
CO6	3	3	2	3	1	2	1	3	**2.3**
Average	**3.0**	**2.7**	**2.2**	**2.0**	**1.0**	**1.3**	**1.5**	**2.2**	**2.00**

Overall Course-PO Mapping Score = 2.00 / 3.00 (66.7%)

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M.Sc. Zoology Course - SEMESTER-III
(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

SERICULTURE

Elective Paper-	**Credits:3**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

Course Outcomes (COs) for SERICULTURE

On the successful completion of the course, student will be able to:		
COs	**Course Outcome**	**K Level**
CO1	Explain the history, scope and organization of sericulture industry in India and Tamil Nadu; describe mulberry cultivation practices including varieties, planting, manuring and pest management.	K2, K4
CO2	Describe silkworm rearing techniques from young age to late age, mounting, cocoon harvest, and non-mulberry silkworm rearing.	K3, K4
CO3	Explain silkworm seed production, life cycle, genetics, voltinism, and disease management.	K2, K4
CO4	Explain post-cocoon technology including stifling, reeling, silk grading, throwing, dyeing, weaving, and by-product utilization.	K2, K3
CO5	Describe sericulture extension systems, government schemes, economics of sericulture, and marketing.	K3, K4
CO6	Develop entrepreneurial skills for sericulture-based small-scale enterprises and prepare project reports.	K5

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

Pre-requisite knowledge: This agro-based a multidisciplinary study need prerequisite knowledge on botany (mulberry cultivation), zoology (silkworm biology).

Unit	Topic Name	Hrs.	K. level
Unit 1: Introduction to Sericulture and Mulberry Cultivation			
Unit 1	Definition, history and scope of sericulture; sericulture industry in India and Tamil Nadu – major sericulture districts (Krishnagiri, Dharmapuri, Salem, Erode, Coimbatore, Mysore)		K1, K2
	Mulberry (Morus spp.) – taxonomy, varieties cultivated in Tamil Nadu (*Morus alba, Morus indica*		K2, K4
	Mulberry cultivation practices – land preparation, planting intercropping		K2, K3
	Mulberry leaf harvesting – leaf plucking methods (leaf quality parameters (moisture, protein, moisture content, NPK content)		K2, K3
	Mulberry pest and disease management – major pests and diseases		K2, K4
Unit 2: Silkworm Rearing Technology			
Unit 2	Silkworm species – *Bombyx mori* (mulberry silkworm) – types of silkworm races (uni/bivoltine, multivoltine) and hybrids; non-mulberry silkworms (Vanya silks) – Tasar (*Antheraea mylitta*), Eri (Samia cynthia ricini), Muga (*Antheraea assamensis)*		K2, K4
	Silkworm rearing house – location, orientation, construction, ventilation, temperature and humidity requirements; rearing appliances (stands, trays, nets, chopping boards, chandrike, mountages)		K2, K3
	Silkworm rearing operations – disinfection, brushing , (Chawki) – methods (box, sheet, shelf), leaf quality and feeding schedule		K3, K4
	Mounting and cocoon harvest – types of mountages (chandrike, bamboo mountage, plastic mountage, rotary mountage), spinning, cocoon harvest time cocoon sorting		K3, K4
Unit 3: Silkworm Seed Production and diseases			
Unit -3	Silkworm egg (seed) production – grainage techniques (mother moth examination (dfl – disease free laying production), silkworm egg incubation		K2, K3
	Silkworm life cycle – egg → larva (5 instars) → pupa → moth; duration and temperature/humidity requirements; moulting (4 moults), larval instar identification		K2, K4
	Voltinism – univoltine, bivoltine, multivoltine races; voltinism control by photoperiod and temperature; diapause (arrested development); non-diapause eggs		K2, K4
	Pests and diseases of silkworm – Protozoan (Pebrine – *Nosema bombycis*, Viral		K2, K4

	(Grasserie, Flacherie), Fungal (Muscardine), Bacterial (Flacherie);signs, symptoms and preventive measures		
Unit 4: Post-Cocoon Technology and Silk Production			
Unit -4	Cocoon processing – stifling (sun drying, steam stifling, hot air drying), cocoon storage, sorting for reeling (raw silk production)		K2, K3
	Silk reeling – definition, types of reeling (charkha, cottage basin, charkha, filature), reeling steps; reeling parameters – reelability, raw silk recovery percentage		K2, K4
	Raw silk grading – quality parameters (denier size, neatness, cleanness, tenacity, elongation, evenness), grading system, export standards		K2, K4
	Silk by-products and value addition – mulberry fruit, silkworm pupae (animal feed, human food – entomophagy), sericin silk waste products		K3, K5
Unit 5: Sericulture Extension, Economics, and Entrepreneurship			
Unit -5	Sericulture extension system in India – Central Silk Board (CSB), Sericulture Training Institutes;		K2, K4
	Sericulture development programmes in Tamil Nadu – government subsidies and schemes; SAMPADA, role of Tamil Nadu Cooperative Silk Federation (TANSILK)		K2, K3
	Economics of sericulture – cost of cultivation of mulberry, cost of silkworm rearing, cocoon yield and price (minimum support price), net return, benefit-cost ratio; Entrepreneurship in sericulture- project report preparation		K3, K4

Learning Outcomes

1. Understand the history and scope in Tamil Nadu, mulberry cultivation practices, and pest and disease management.

2. Comprehend silkworm rearing techniques for Bombyx mori and non-mulberry silkworms, mounting, cocoon harvest, and sorting.

3. Grasp silkworm seed production including DFL, life cycle, voltinism, and disease management for Pebrine and Grasserie.

4. Recognize post-cocoon technology including stifling, reeling by charkha and cottage basin, silk grading, and by-products.

5. Understand sericulture extension systems, government schemes such as TANSILK, economics, and marketing.

6. Appreciate development of entrepreneurial skills, calculate costs and returns, and prepare project reports for sericulture enterprises.

Reference Books

1.	Sericulture for Rural Development H.G. Hanumappa (Editor) Himalaya Publishing House, Bombay
2.	Silk Production and Weaving in India C.C. Ghosh CSIR, New Delhi (1949)
3.	Sericulture Practices B. Sannappa Regional Institute of Education, Mysuru (2017)
4.	Tripathi, A. K., Jaiswal, K., Trivedi, S., & Pandey, B. N. (2009). Mulberry sericulture: Problems and prospects. Daya Publishing House

Textbooks

5.	Textbook of Sericulture, Apicultural and Entomology, TNAU Faculty, Kalyani Publishers, 2017
6.	Rao, M. M. M. (2006). An introduction to sericulture. Oxford & IBH Publishing Co
7.	Handbook of Practical Sericulture S.R. Ullal & M.N. Narasimhanna Central Silk Board, Bangalore
8.	An Introduction to Sericulture G. Ganga & J. Sulochana ChettyOxford & IBH Publishing Co., New Delhi.
9.	Gupta, R. (2022). Fundamentals of sericulture. Daya Publishing House.

Online Resources (Free or Accessible)

10.	**Khan Academy – Economics (for Entrepreneurship Unit) Video Library https://www.khanacademy.org**
11.	**Silk Mark Organization of India (SMOI) Quality Certification https://www.silkmark.org.in**
12.	**International Sericultural Commission (ISC) International Organization https://inserco.org**
13.	**Central Silk Board (CSB), Government of India Government Portal https://csb.gov.in**
14.	**Tamil Nadu Agricultural University – Sericulture Department University Portal https://tnau.ac.in (Search: Sericulture)**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	2	1	1	2	1	2	**1.8**
CO2	3	2	3	2	1	1	1	2	**1.9**
CO3	3	3	2	2	2	1	2	2	**2.1**
CO4	3	2	2	1	1	1	1	2	**1.6**

CO5	3	3	1	2	1	2	1	2	**1.9**
CO6	3	3	2	3	1	2	1	3	**2.3**
Average	**3.0**	**2.5**	**2.0**	**1.8**	**1.2**	**1.5**	**1.2**	**2.2**	**1.928**

Final Overall Matrix Score = 1.928/3.00=64.26%

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ORNAMENTAL FISH CULTURE

Non major Paper-	**Credits:2**	**Paper Code:**
Total Contact Hours:36		**Weekly Contact Hours: 3**

Course Outcomes (COs) for Ornamental Fish Culture

On the successful completion of the course, student will be able to:		
COs	**Course Outcome**	**K Level**
CO1	Explain the scope of ornamental fish culture in Tamil Nadu, set up and maintain a basic home aquarium.	K2, K3
CO2	Identify common freshwater, brackishwater, and marine ornamental fish species and their characteristics.	K1, K2
CO3	Culture live food organisms (Artemia, Daphnia) and prepare formulated feeds for ornamental fish.	K3, K4
CO4	Breed common ornamental fish (livebearers and egg layers) and manage fish health and diseases.	K3, K4
CO5	Plan and design a small-scale commercial ornamental fish farm and calculate economics.	K3, K4
CO6	Apply government schemes for ornamental fish farming and prepare fish for domestic/export marketing.	K3, K5

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

Pre-requisite knowledge: Includes understanding fish anatomy and taxonomy, the nitrogen cycle for safe water management, and the nutritional needs for live feed

Unit	Topic Name	Hrs.	K. level
Unit 1: Introduction to Ornamental Fish Culture and Aquarium Setup			
Unit 1	Importance and scope of ornamental fish culture –ornamental fish industry in India and Tamil Nadu (Madurai, Chennai, Ramanathapuram, Thoothukudi)		K1, K2
	Types of ornamental fish farming – freshwater, brackishwater, marine; small-scale hobby vs. commercial farming		K2, K4
	Setting up a home aquarium – types of aquariums (glass, acrylic), size selection, location, accessories		K2, K3
	Aquarium maintenance – water quality parameters (temperature, pH, dissolved oxygen, ammonia, nitrite, nitrate), cleaning schedule, gravel cleaning, partial water change, algae control		K3, K4
	Aquarium plants – types (Java moss, Java fern, Amazon sword, Anubias, Vallisneria, Hornwort, Duckweed), uses (oxygenation, shelter, spawning, aesthetics), planting methods		K2, K3
Unit 2: Popular Ornamental Fish Species and Their Characteristics			
Unit 2	Livebearers – Guppy (Poecilia reticulata), Molly (Poecilia sphenops), Platy (Xiphophorus maculatus), Swordtail (Xiphophorus helleri) – characteristics, size, water requirements, feeding, behavior		K1, K2
	Egg layers – Fighter / Betta (Betta splendens), Gourami (Trichogaster sp.), Angelfish (Pterophyllum scalare), Goldfish (Carassius auratus), Koi Carp (Cyprinus rubrofuscus), Zebra fish (Danio rerio), Tiger Barb, Red-tailed Shark		K1, K2
	Marine ornamental fishes – Clownfish (Amphiprion sp.), Blue Tang (Paracanthurus hepatus), Angelfish (Pomacanthidae), Butterflyfish (Chaetodontidae)		K1, K2
Unit 3: Feed Management and Live Food Culture			
Unit -3	Natural food organisms for ornamental fish – microalgae (Spirulina, Chlorella, Nannochloropsis), zooplankton (Rotifers – Brachionus, Daphnia, Moina, Artemia brine shrimp, Cyclops), worms (Tubifex, bloodworms, microworms)		K2, K3
	Culture of Artemia (brine shrimp) – hatching of cysts, decapsulation, nauplii harvest, enrichment		K3, K4
	Formulated feeds – types (flake, pellet, tablet, stick, gel), ingredients, preparation of home-made feed, commercial feeds, feeding frequency and quantity		K3, K4
	Feeding management – feeding behavior of different species (surface, mid-water,		K3, K4

	bottom feeders), feeding schedule, overfeeding prevention, feed storage		
Unit 4: Breeding Technology and Health Management			
Unit -4	Breeding of livebearers – sexual dimorphism (male vs. female), courtship, gestation period, fry care, breeding trap use		K3, K4
	Breeding of egg layers – conditioning brooders, spawning triggers (temperature, water change, feeding), spawning sites (Java moss, mop, spawning slate), egg care, fry rearing		K3, K4
	Breeding of Goldfish and Koi – outdoor pond breeding, spawning mops, hormone-induced breeding (for Koi), fry management		K3, K4
	Common diseases of ornamental fish – causes (stress, poor water quality, overfeeding, introduction of infected fish), symptoms and treatment: Disease prevention and quarantine – quarantine protocol for new fish,		K2, K4
Unit 5: Commercial Farming, Economics, Trasport and Marketing			
Unit -5	Commercial ornamental fish farm – farm design (cement tanks, raceways, FRP tanks, earthen ponds), water supply and drainage system, aeration, greenhouse farming, hatchery unit		K2, K3
	Economics of ornamental fish farming – capital investment (land, tanks, equipment, brood stock), recurring costs (feed, electricity, labour, medicine), income (profit calculation, benefit-cost ratio, break-even analysis		K3, K4
	Packing and transportation of ornamental fish – conditioning before transport (starving), packing methods (oxygen filling, double bagging), packing density calculation, use of anaesthetics (MS-222, clove oil), transportation (local, domestic, international), export procedures		K3, K4
	Marketing channels – domestic market (local pet shops, aquarium stores, online sales), export market (MPEDA, export hubs), marketing strategies (social media, exhibitions, aquarium shows), value-added products (ornamental fish, plants, accessories)		K3, K5
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand the scope in India and Tamil Nadu, differentiate freshwater and marine culture, and set up and maintain a home aquarium.
2. Comprehend freshwater and marine ornamental fish species and select compatible groups for a community aquarium.
3. Grasp culture of live food organisms including Artemia, Daphnia, and rotifers, prepare formulated feeds, and manage feeding.
4. Recognize breeding of livebearers and egg layers, manage fish health and diseases, and apply quarantine protocols.
5. Understand planning of a small-scale commercial farm, design systems, and calculate economics including capital, costs, profit, and BCR.
6. Appreciate government schemes such as PMMSY, prepare fish for transport, and identify domestic and export marketing channels.

Reference Books

1.	Marine Ornamental Fishes – an Introduction (Booklet, 2018) Anand, C., Stephen Sampathkumar, J., Jawahar, P., Gokulakrishnan, S., Ramesh, P. MCeSA, Tamil Nadu Dr. J. Jayalalithaa Fisheries University (TNJFU) TNJFU publication – Introduction to marine ornamental fishes; 14 pages
2.	Marine Ornamental Fishes, Culture Techniques and Conservation Methods (2016) Jawahar, P., Anand, C., Gokulakrishnan, S., Murugananthan, A., Dinesh Babu, P. TNJFUMarine ornamental fish culture techniques and conservation methods
3.	Skill Development Manual for Shrimp Farm Assistants (2017) Anand, T., Meeran, M.N., Anand, C., Santhoshkumar, S., Amirtharaj, K.S.V., Kannan, B. DEE, Tamil Nadu Fisheries University Includes ornamental fish farming skills

Textbooks

4.	Tropical Freshwater Ornamental Fish Culture Ramanathan et al. (2000) Department of Fisheries Farm Management, Tamil Nadu Veterinary and Animal Sciences University (TANUVAS), Chennai Official TANUVAS textbook – Covers tropical freshwater ornamental fish culture; recommended in Bharathidasan University syllabus
5.	Ornamental Fish Culture Technology Jameson, J.D., Srinivasan, A. and Venkataramanujam (1995) TANUVAS Publication, Chennai TANUVAS publication – Comprehensive coverage of ornamental fish farming technologies
6.	Manual of Ornamental Fishes and Farming Technologies Jameson, J.D. and Santhanam, R. (1996) Peejay,

	Thoothukkudi Thoothukkudi-based publication – Practical manual covering farming technologies
7.	Hand Book of Aqua Farming Dey, V.K. (1995) MPEDA, India MPEDA publication – Covers aqua farming practices including ornamental fish
Online Resources (Free or Accessible)	
8.	**Tamil Nadu Dr. J. Jayalalithaa Fisheries University (TNJFU) University Portal https://www.tnjfu.ac.in**
9.	**ICAR-CIBA – Ornamental Fish Breeding Programmes Research Institute https://ciba.res.in**
10.	**NFDB – National Fisheries Development Board Government Portal https://nfdb.gov.in**
11.	**MPEDA – Marine Products Export Development Authority Government Portal https://mpeda.gov.in**
12.	**PMMSY – Pradhan Mantri Matsya Sampada Yojana Government Scheme https://pmmsy.gov.in**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	3	1	1	2	1	2	**1.9**
CO2	3	2	2	1	1	2	1	2	**1.8**
CO3	3	3	3	2	1	1	1	2	**2.0**
CO4	3	3	3	2	1	1	3	2	**2.3**
CO5	3	3	2	2	1	2	1	2	**2.0**
CO6	3	3	2	3	1	2	1	3	**2.3**
Average	**3.0**	**2.7**	**2.5**	**1.8**	**1.0**	**1.7**	**1.3**	**2.2**	**2.035**

Final Overall Matrix Score = 2.035/3.00=67.83%

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VERMICULTURE

Non major Paper-	**Credits:2**	**Paper Code:**
Total Contact Hours:36		**Weekly Contact Hours: 3**

Course Outcomes (COs) for Vermiculture

On the successful completion of the course, student will be able to:

COs	Course Outcome	K Level
CO1	Explain the scope, importance and basic principles of vermiculture and vermicomposting in Tamil Nadu.	K2, K4
CO2	Identify different earthworm species used for vermicomposting and describe their biology.	K1, K2
CO3	Set up and manage a vermicompost unit using different methods (bed, pit, tank method).	K3, K4
CO4	Harvest vermicompost, test quality parameters, and prepare vermiwash.	K3, K4
CO5	Plan a small-scale commercial vermicompost unit and calculate economics.	K3, K4
CO6	Apply government schemes for vermicompost units and develop entrepreneurial skills.	K5

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

Pre-requisite knowledge: Knowledge spanning earthworm biology, environmental parameters, and organic waste management.

Unit	Topic Name	Hrs	K. level
Unit 1: Introduction to Vermiculture and Vermicomposting			
Unit 1	Definition, scope and importance of vermiculture and vermicomposting in Tamil Nadu agriculture		K1, K2
	History of vermicomposting – global and Indian perspectives;		K1, K2
	Advantages of vermicompost over chemical fertilizers – soil health improvement, nutrient availability, cost-effectiveness, environmental benefits vermicompost in sustainable agriculture and solid waste management		K2, K4
	Basic principles of vermicomposting – aerobic decomposition, microbial activity, earthworm action		K2, K3
Unit 2: Earthworm Species and Biology			
Unit 2	Types of earthworms – epigeic, endogeic, anecic – characteristics and habitat preferences		K2, K4
	Important vermicomposting earthworm species – Eisenia fetida (Red wiggler), Eudrilus eugeniae (African night crawler), Perionyx excavatus (Indian blue worm) – identification, life cycle, feeding habits		K1, K2
	Earthworm anatomy and physiology – digestive system, reproductive system (hermaphrodite, clitellum, cocoon formation), nervous system		K2, K4
	Factors affecting earthworm growth and reproduction – temperature		K2, K4
Unit 3: Vermicomposting Technology and Methods			
Unit -3	Types of vermicomposting methods – bed method, pit method, pot method, tank method, vermibed, vermitank, high-rate vermicomposting systems		K2, K3
	Selection of site and construction of vermicompost unit ; Substrate / bedding materials		K3, K4
	Bed preparation and earthworm inoculation – layering of substrate (bottom gravel/sand, middle organic waste, top cow dung), earthworm stocking density (1–2 kg worms per square meter), feeding schedule		K3, K4
Unit 4: Vermicompost Harvesting, Quality Control, and Management			
Unit -4	Vermicomposting process management – moisture management -watering schedule, temperature control, pH monitoring, aeration, turning, protection from predators (ants, birds, rats, lizards)		K3, K4
	Harvesting of vermicompost – timing (45–60 days), harvesting methods (light trap method, migration method, manual separation, screening)		K3, K4
	Vermicompost quality parameters – color (dark brown/black), texture (fine, granular), odor (earthy), pH (6.5–7.5), electrical conductivity (EC), organic carbon, NPK content		K2, K4

	Vermiwash – definition, preparation method (collection through PVC pipe or plastic bottle), dilution and application in crops (foliar spray, soil drench), nutrient content, benefits		K3, K4
	Earthworm harvesting and multiplication – separation for next batch, sale of earthworms (cocoon, juvenile, adult), packing and transport, packaging (moist cocopeat/coir)		K3, K4
Unit 5: Commercial Vermicomposting, Economics, and Entrepreneurship			
Unit -5	Large-scale commercial vermicompost production – farm design, mechanized systems		K3, K4
	Economics of vermicompost production – budget and profit		K3, K4
	Government schemes and subsidies for vermicompost in Tamil Nadu – NABARD subsidy (25–33% of project cost), KVK training programmes on vermicompost production, SHG support		K2, K4
	Entrepreneurial opportunities in vermicomposting – small-scale vermicompost unit, earthworm production (worm farming), vermiwash unit, supply to organic farmers, vermicompost as soil conditioner, waste management service (municipal, hotel, agricultural waste), value-added products		K5
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand the scope, importance, and principles of vermicomposting, advantages over chemical fertilizers, and role in waste management.
2. Comprehend earthworm species including Eisenia, Eudrilus, and Perionyx, describe their biology, and factors affecting growth.
3. Grasp setting up a vermicompost unit using bed or pit methods, select substrates, calculate the C:N ratio, and manage feeding.
4. Recognize harvesting of vermicompost, test quality parameters including pH and NPK, prepare vermiwash, and multiply earthworms.
5. Understand planning of a commercial unit, calculate economics, and identify government subsidies from NABARD and KVIC.
6. Appreciate government schemes, develop entrepreneurial skills, and prepare a project report for a vermicompost enterprise.

Reference Books

1.	Edwards, C. A., Arancon, N. Q., & Sherman, R. L. (2010). Vermiculture technology: Earthworms, organic wastes, and environmental management. CRC Press.
2.	Sherman, R. (2018). The worm farmer's handbook: Mid- to large-scale vermicomposting for farms, businesses, municipalities, schools, and institutions. Chelsea Green Publishing.
3.	Introductory & Crop Application TextbookWalia, S. S., & Kaur, T. (2024). Earthworms and vermicomposting: Species, procedures and crop application. Springer.
4.	NPCS Board of Consultants & Engineers. (2003). The complete technology book on vermiculture and vermicompost. NIIR Project Consultancy Services.

Textbooks

5.	On vermitechnology for soil and plant health:Ismail, S. A. (2005). The earthworm book . India Press.
6.	Gupta, P. K. (2020). Vermicomposting for sustainable agriculture (2nd ed.) [Print]. Agrobios Publications
7.	Singh, K. (2014). Textbook of vermicompost: Vermiwash and biopesticides [Hardcover]. Biotech Books.
8.	Handbook of Vermicomposting N. K. Mani, Tamil Nadu)

Online Resources (Free or Accessible)

9.	**TNAU – Waste Recycling and Vermicomposting Certificate Course Certificate Course (Tamil Medium) https://tnau.ac.in/site/odl/certificate-courses/**
10.	**TNAU – Vermicomposting Demonstrations Extension Activities https://tnau.ac.in/site/college-acri-killikulam/department-of-soil-science-hods-desk/**
11.	**TNAU KVK Kanyakumari – Vermicompost Training KVK Portal https://tnau.ac.in/site/kvk-kanyakumari/linkages/**
12.	**NABARD – Vermicompost Subsidy Schemes Government Schemehttps://www.nabard.org**
13.	**https://www.bhumipublishing.com/wp-content/uploads/2025/04/Textbook-of-Vermiculture-and-Vermicomposting.pdf**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average

CO1	3	2	3	1	3	3	2	2	**2.38**
CO2	3	2	2	1	1	2	2	2	**1.88**
CO3	3	3	3	2	2	3	1	2	**2.38**
CO4	3	3	3	2	1	2	2	2	**2.25**
CO5	3	3	2	2	2	2	1	2	**2.13**
CO6	3	3	2	3	1	2	1	3	**2.25**
Average	**3.00**	**2.67**	**2.50**	**1.83**	**1.67**	**2.33**	**1.50**	**2.17**	**2.20**

Final Overall Matrix Score = 2.20/3.00=73.33%

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636 011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-III

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

INTERNSHIP/ FIELD SURVEY/ INDUSTSRIAL ACTIVITY

Industry module Practice -	**Credits:1**	**Paper Code:**
Total Contact Hours:		**Weekly Contact Hours:**

Course Objectives:

It fills the gap between academic theory and practical application. It allows you to gain hands-on industry experience, develop both technical and professional soft skills, build a network of professional contacts, and explore specific career paths before committing to them permanently

Expected Course Outcome:

1. Application of theoretical knowledge to real-world problems
2. Development of professional & communication skills
3. Awareness of industry standards & professional ethics

Course	**:**	**Internship/ Field Survey/ Industrial Activity**
Course title	**:**	**Internship/ Field Survey/ Industrial Activity**
Credits	**:**	**1**

Pre-requisite: Before undertaking an internship in a life sciences, biotechnology, or biochemistry laboratory (academic research, clinical diagnostics, pharmaceutical industry, or biotech industry), students must possess a foundation of theoretical knowledge, practical laboratory skills, and professional competencies. These pre-requisites ensure the student can work independently, follow safety protocols, and meaningfully contribute to the host organization's objectives.

Course Learning Outcome

CLO No.	Course Learning Outcome	Bloom's Level	Related POs	Score
CLO1	Apply theoretical knowledge and practical skills in professional settings	K3	PO1, PO3	**2.50**
CLO2	Perform experiments with precision, accuracy, and adherence to SOPs/GLP	K3	PO3, PO4, PO5	**2.50**
CLO3	Analyze and interpret data using statistical and bioinformatics tools	K4	PO2, PO7	**2.25**
CLO4	Demonstrate scientific communication through reports, logbooks, and presentations	K3	PO6, PO7	**2.38**
CLO5	Exhibit awareness of biosafety, ethics, and regulatory compliance	K3	PO5, PO8	**2.25**
CLO6	Collaborate effectively in teams with professionalism and adaptability	K3	PO6, PO8	**2.25**
CLO7	Evaluate internship relevance to career goals and identify areas for development	K4, K5	PO8	**2.00**

Final Overall Matrix Score 2.31 / 3.00 (77.0%)

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M.Sc. Zoology Course - SEMESTER-III

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FISHERY BIOLOGY AND AQUACULTURE

Skill enhancement Paper-	**Credits:2**	**Paper Code:**
Total Contact Hours:36		**Weekly Contact Hours: 3**

Course Outcomes (COs) for Fishery biology and Aquaculture

On the successful completion of the course, student will be able to:		
	Course Outcome	**K Level**
CO1	Explain the scope of fisheries and aquaculture, classify fisheries types, describe history, and identify important cultivable fish species.	**K1, K2**
CO2	Describe external morphology, morphometry, meristics, feeding habits, age and growth determination methods, and reproductive biology of fishes.	**K2, K3**
CO3	Explain types of aquaculture systems, pond management, cage/pen culture, RAS, composite fish culture, integrated farming, and water quality management.	**K2, K3**
CO4	Describe fish nutrition, feed formulation, FCR calculation, live food culture, induced breeding, hatchery management, and fish disease control.	**K3, K4**
CO5	Explain fish population dynamics, stock assessment, sustainable fisheries, fisheries laws, harvesting, processing, preservation, and marketing.	**K2, K4**
CO6	Calculate economics of aquaculture (break-even analysis, BCR), identify government schemes (PMMSY, NABARD), and develop entrepreneurial opportunities.	**K3, K5**

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

Pre-requisite knowledge: Requires a core understanding of biological sciences, specifically zoology, ecology, chemistry, are used to grasp the anatomy, physiology, and environmental interactions of aquatic species.

Unit.	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Foundations of Fisheries – Definition, Scope, Resources, and Development			
Unit 1	Definition, scope, and importance of fisheries and aquaculture		K1, K2
	Global and Indian fisheries resources		K1, K2
	Types of fisheries: marine, inland, brackish water		K2, K4
	History and development of aquaculture		K1, K2
	Basic concepts: capture fisheries vs culture fisheries		K2, K4
Unit 2: Fish Biology – Morphology, Feeding, Growth, and Reproduction			
Unit 2	External morphology of fishes and identification		K1, K2
	Morphometry and meristics – external morphology of fish (body parts – head, trunk, tail; fins – dorsal, caudal, anal, pectoral, pelvic; scales – cycloid, ctenoid, placoid, ganoid); morphometric measurements (total length, standard length, fork length); meristic counts (fin rays, scales, gill rakers, vertebrae)		K2, K3
	Feeding habits and digestion – types of feeders; gastro-somatic index (GaSI); length-weight relationship ($W = aL^b$ – cube law)		K2, K3
	Age and growth determination – methods of age determination (scale reading, otolith analysis, opercular bone, vertebrae); length-frequency distribution		K3, K4
	Reproductive biology: gonadal development, spawning behavior, fecundity		K2, K4
Unit 3: Aquaculture Systems – Types, Pond Management, and Integrated Farming			
Unit-3	Types of aquaculture systems: extensive, semi-intensive, intensive		K2, K4
	Pond culture: site selection, pond construction, and management		K2, K3
	Cage culture, pen culture,		K2, K4
	Composite fish culture and polyculture techniques		K2, K4
	Integrated fish farming poultry, (Pokkali fish + agriculture)		K2, K4
Unit 4: Fish Nutrition, Feed Technology, Breeding, and Health Management			
Unit-4	Nutritional requirements of fish: proteins, lipids, carbohydrates, vitamins		K1, K2
	Fish nutrition and feed technology – nutrient requirements; feed ingredients; feed formulation (Pearson square method); types of feed (floating, sinking, pelleted, crumble, microencapsulated, moist feed); feed conversion ratio (FCR = feed given / weight gain) – calculation and significance		K3, K4
	Live food culture – types of live food organisms: Artemia brine shrimp –culture		K3, K4

	methods (batch culture, continuous culture); harvesting (sieving)		
	Induced breeding techniques (hypophysation)		K2, K3
	Hatchery management and seed production		K2, K3
	Fish diseases: bacterial, viral, parasitic, fungal		K2, K4
Unit 5: Fisheries Management, Stock Assessment, Policies, Processing, and Economics			
Unit-5	Fish population dynamics and stock assessment		K4, K5
	Sustainable fisheries and conservation strategies		K2, K4
	Fisheries laws and policies (India focus)		K2, K4
	Harvesting, processing, and preservation techniques		K2, K3
	Marketing and export of fish products		K2, K3
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand the scope of fisheries, classify fishery types, describe the history of aquaculture, and identify cultivable fish species.

2. Comprehend fish morphology, morphometry, meristics, feeding habits, age and growth determination, and reproductive biology.

3. Grasp aquaculture systems from extensive to intensive, pond management, recirculating aquaculture systems, and water quality management.

4. Recognize fish nutrition, feed formulation including FCR, live food culture, induced breeding, hatchery management, and disease control.

5. Understand fish population dynamics, sustainable fisheries, laws, harvesting methods, processing, and marketing.

6. Appreciate the economics of aquaculture, identify government schemes such as PMMSY, and develop entrepreneurial opportunities.

Books

1.	Srivastava, C. B. L., & Srivastava, S. (2017). Fishery biology. Atlantic Publishers & Distributors.
2.	Srivastava, C. B. L. (2013). A text book of fishery science and Indian fisheries (2nd ed.). Kitab Mahal Publishers.
3.	Rath, R. K. (2004). Freshwater aquaculture. Scientific Publishers.
4.	Kar, D. (2007). Fundamentals of limnology and aquaculture biotechnology. Daya Publishing House.
5.	Jhingran, V. G. (2006). Handbook of fisheries and aquaculture. ICAR Publications.
6.	Khune, C. J., Tijare, R. V., Sitre, S. R., & Zade, S. B. (2022). Principles of aquaculture. Himalaya Publishing House.
7.	Gopakumar, K. (2002). Textbook of fish processing technology. Indian Council of Agricultural Research.
8.	Govindan, T. K. (1985). Fish processing technology. Oxford & IBH Publishing.
9.	Mishra, R. (2018). Handbook on fish processing and preservation. Narendra Publishing House.
10.	Balasubramanian, A., et al. (2019). Handbook on fisheries biology and resource management. Narendra Publishing House.
11.	**Online Resources (Free or Accessible)**
12.	**https://www.cife.edu.in/online-e-books**
13.	**https://www.cmfri.org.in/ebooks**
14.	**https://agritech.tnau.ac.in/fishery/fish_index.html**
15.	**https://ebook.icar.org.in/index.php/bookprocess/ugbscfish_list**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	1	1	1	2	1	2	**1.6**
CO2	3	3	2	2	2	2	1	2	**2.1**
CO3	3	2	3	2	1	2	1	2	**2.0**
CO4	3	3	3	2	1	1	3	2	**2.3**
CO5	3	3	2	2	2	3	1	2	**2.3**
CO6	3	3	2	3	2	2	1	3	**2.4**
Average	**3.0**	**2.7**	**2.2**	**2.0**	**1.5**	**2.0**	**1.3**	**2.2**	**2.114**

Final Overall Matrix Score = 2.114/3.00=70.46%

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PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-III

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

MOOC- SWAYAM COURSE*

MOOC Paper-	**Credits:2**	**Paper Code:**
Total Contact Hours: Self		**Weekly Contact Hours: 0**

*Optional only and Credit transfer available

Course Objectives (General Framework)

The primary objectives of a SWAYAM MOOC course are to provide flexible, self-paced learning opportunities that leverage digital technology to reach a wide audience. More specifically, for life sciences and related fields, students will be able to:

- **Gain Exposure:** Access diverse, high-quality multimedia learning resources to understand advanced scientific concepts while enhancing professional development.
- **Apply Knowledge:** Use theoretical knowledge and practical laboratory skills to execute tasks independently in professional or research settings.
- **Develop Professional Skills:** Enhance problem-solving, collaboration, and critical thinking skills through interactive learning.

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DEPARTMENT OF ZOOLOGY

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M.Sc. Zoology Course - SEMESTER-IV

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

EVOLUTION

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

Course Outcomes (COs) for EVOLUTION

On the successful completion of the course, student will be able to:		
COs	**Course Outcome**	**K Level**
CO1	Explain historical theories of evolution (Lamarck, Darwin), the Modern Synthesis, and analyze multiple lines of evidence supporting evolution.	**K2, K4**
CO2	Apply Hardy-Weinberg equilibrium to detect evolutionary change and analyze mechanisms of evolution (mutation, gene flow, drift, selection).	**K3, K4**
CO3	Compare species concepts, classify modes of speciation, and analyze reproductive isolating mechanisms.	**K2, K4**
CO4	Explain major evolutionary transitions including the origin of life, geological time scale events, and human evolution.	**K2, K4**
CO5	Analyze macroevolutionary patterns (adaptive radiation, convergent evolution, punctuated equilibrium) and Evo-Devo concepts (Hox genes).	**K4, K5**
CO6	Apply evolutionary principles to real-world problems including evolutionary medicine, conservation genetics, and phylogenetics.	**K4, K5**

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

Pre-requisite knowledge: Genetics and Inheritance, Ecology and Population Dynamics

Unit	Topic Name	Hrs.	K. level
Unit 1: Historical Development and Evidence for Evolution			
1	Theories of evolution before Darwin: Lamarckism (inheritance of acquired characters), Catastrophism (Cuvier),		K1, K2
	Darwinism: Natural selection, Darwin's finches, postulates of natural selection; Alfred Russel Wallace's contribution		K2, K4
	Modern Synthetic Theory of Evolution (Neo-Darwinism): Integration of Darwinism with Mendelian genetics and population genetics (Haldane, Fisher, Wright, Dobzhansky, Mayr, Simpson)		K2, K4
	Evidence for evolution: Comparative anatomy (homologous, analogous, vestigial organs), Embryological (recapitulation theory – Haeckel's biogenetic law, von Baer's laws), Fossils and dating methods (Carbon, Potassium-argon and Uranium)		K2, K4
Unit 2: Population Genetics and Mechanisms of Evolution			
2	Hardy-Weinberg equilibrium: applications in detecting evolutionary change		K3, K4
	Factors affecting gene frequencies: Mutation, Gene flow (migration), Genetic drift (bottleneck effect, founder effect), Natural selection		K4, K5
	Types of natural selection: Directional, stabilizing, disruptive, balancing selection sexual selection		K2, K4
	Inbreeding and Out breeding, inbreeding depression: Effects on genetic diversity, coefficient of inbreeding.		K3, K4
Unit 3: Speciation and Macroevolution			
3	Concept of species: Biological species concept,		K2, K4
	Modes of speciation: Allopatric speciation (peripatric, centrifugal), Sympatric speciation (polyploidy, habitat differentiation, sexual selection), Parapatric speciation (hybrid zones)		K2, K4
	Reproductive isolating mechanisms : Pre-zygotic (habitat, temporal, behavioral, mechanical, gametic isolation), Post-zygotic (hybrid inviability, hybrid sterility, hybrid breakdown)		K2, K4
	Macroevolution: Patterns (adaptive radiation – Darwin's finches; convergent evolution, divergent evolution, parallel evolution, punctuated equilibrium vs. phyletic gradualism) ; Mimicry and Colouration.		K4, K5
Unit 4: Origin of Life and Major Evolutionary Transitions			

4	Origin of life: Oparin-Haldane theory (primordial soup), Miller-Urey experiment, RNA world hypothesis		K2, K4
	Geological time scale and major events		K2, K4
	Evolution of major taxa: Origin of eukaryotes, evolution of multicellularity,		K2, K4
	Coevolution: Mutualism (flowers and pollinators, ants and acacias), predator-prey (arms race – cheetah/gazelle), host-parasite (Red Queen hypothesis), Altruism and Kin selection		K4, K5
Unit 5: Evolutionary Genetics, Development, and Applications			
5	Molecular evolution: Neutral theory of molecular evolution (Kimura), molecular clock hypothesis, synonymous vs. non-synonymous mutations (Ka/Ks ratio)		K4, K5
	Origin of new genes and proteins; gene duplication and divergence		K4, K5
	Human evolution: Hominin lineage – Australopithecus, Homo habilis, Homo erectus, Neanderthals, Homo sapiens; key adaptations		K2, K4
	Applications of evolutionary biology: Evolutionary medicine (antibiotic resistance, evolution of virulence), conservation genetics (minimum viable population, genetic rescue), agriculture (crop domestication, pesticide resistance), forensics (molecular phylogenetics)		K4, K5
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand historical theories including Lamarck and Darwin, the Modern Synthetic Theory, and evidence for evolution.

2. Comprehend Hardy-Weinberg equilibrium, analyze mechanisms of evolution, and understand inbreeding and outbreeding.

3. Grasp species concepts, classify modes of speciation, and analyze reproductive isolating mechanisms.

4. Recognize the origin of life, geological time scale, coevolution, and altruism with kin selection.

5. Understand macroevolutionary patterns, Evo-Devo concepts, molecular evolution, and human evolution.

6. Appreciate application of evolutionary principles to medicine, conservation, agriculture, forensics, and phylogenetics.

Reference Books

1.	Strickberger. M. W. 2000. Evolution. Third Edition, Jones Bartlett Publishers
2.	Futuyma, D. J., & Kirkpatrick, M. (2017). *Evolution* (4th ed.). Sinauer Associates.
3.	Colbert, E.H. Evolution of the Vertebrates. (Wiley Eastern Ltd.). 535 pages.
4.	Rensch, B., 1959. Evolution above the species level. (Methuen & Co. Ltd.) 419 pages
5.	Dobzhansky, T., 1955. Evolution, Genetics & Man. (Wiley Eastern Pvt. Ltd. 398 pages.
6.	Freeman, S. & Herron,J. C., 1998. Evolutionary analysis. (Prentice Hall, Inc.). 786 pages
7.	Gillespie, J.H., 1991. The causes of molecular evolution. Oxford Univ. Press, New York
8.	Kuppers, B-O., 1983. Molecular theory of evolution. Springer-Verlag, Berlin.

Textbooks

9.	Lull, R.S., 1977. Organic Evolution. (McMillan Co.).
10.	Rastogi, V. B. (2018). *Organic evolution* (3rd ed.). MedTech.
11.	M.P. Arora, 2000. Organic evolution. (Himalaya Publ. House). 332 pages.
12.	Ibid. 1990. Evolutionary biology. (Himalaya Publ. House). 134 pages.

Online Resources (Free or Accessible)

13.	**Understanding Evolution (UC Berkeley) Interactive Tutorials https://evolution.berkeley.edu**
14.	**iBiology – Evolution Videos Video Lectures https://www.ibiology.org (Search: Evolution)**
15.	**HHMI BioInteractive – Evolution Videos, Animations, Virtual Labs https://www.biointeractive.org (Search: Evolution)**
16.	**NPTEL – Evolution (MZC-09) Free Online Course https://nptel.ac.in (Search: Evolution)**
17.	**Khan Academy – Evolution and the Tree of Life Video Library https://www.khanacademy.org (Search: Evolution)**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	2	1	1	1	2	1	2	**1.6**
CO2	3	3	2	2	2	2	2	2	**2.3**
CO3	3	3	1	1	2	2	1	2	**1.9**
CO4	3	2	1	1	1	3	1	2	**1.8**
CO5	3	3	1	2	2	2	2	2	**2.1**
CO6	3	3	2	2	2	3	3	3	**2.6**
Average	**3.0**	**2.7**	**1.3**	**1.5**	**1.7**	**2.3**	**1.7**	**2.2**	**2.05**

Final Overall Matrix Score = 2.05/3.00=68.33%

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M.Sc. Zoology Course - SEMESTER-IV

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

ECOLOGY

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

Course Outcomes (COs) for Ecology

On the successful completion of the course, student will be able to:		
COs	**Course Outcome**	**K Level**
CO1	Explain fundamental ecological concepts including environment, habitat, niche, population characteristics, and metapopulation dynamics.	K2, K4
CO2	Analyze community structure, ecological succession, ecosystem functions, and biogeographical zones of India.	K4, K5
CO3	Classify species interactions, identify environmental pollution types, and propose waste management strategies.	K2, K3, K4
CO4	Describe levels of biodiversity, analyze threats, evaluate conservation initiatives (Project Tiger, Biosphere Reserves), and identify Indian biodiversity.	K2, K4, K5
CO5	Explain climate change causes, impacts, mitigation strategies, and the role of international organizations (IPCC, UNFCCC).	K2, K4
CO6	Summarize key environmental acts (WPA, EPA, Biodiversity Act), rules (waste management), and international conventions (CITES, Ramsar, Kyoto, Montreal Protocol).	K2, K4

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

Pre-requisite knowledge: Biotic and Abiotic factors and their interactions in environment			
Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Ecological Principles – Environment, Habitat, Niche, and Population Ecology			
1	The Environment –Basics of Environment and Ecology –types of environments; Physical, biotic, and abiotic components; types and features of environment; Habitat and Niche – Concept of habitat and niche;		K1, K2
	Population Ecology – Population characteristics (density, natality, mortality, age structure); population growth curves (exponential and logistic); population regulation (density-dependent and density-independent factors)		K3, K4
	Life History Strategies – r and k selection; metapopulation		K2, K4
Unit 2: Community Ecology, Succession, and Biogeography			
2	Community Ecology – Nature of communities; community structure and attributes; levels of species diversity and its measurement (Shannon index, Simpson index); edges and ecotones		K3, K4
	Ecosystem – Structure and function; energy flow and mineral cycling (N, P); primary production and decomposition; food chains and food webs; ecological pyramids		K2, K4
	Biogeography –biogeographical zones of India (Trans-Himalayan, Himalayan, Desert, Semi-arid, Western Ghats, Deccan Peninsula, Gangetic Plain, Coasts, North-East), Zoogeography of India		K4, K5
Unit 3: Species Interactions, Pollution, and Environmental Degradation			
3	Species Interactions – Types of interactions (competition, predation, parasitism, mutualism, commensalism, amensalism); interspecific competition; herbivory; carnivory; pollination; symbiosis		K2, K4
	Pollution and Environmental Degradation – soil erosion, desertification; air pollution; plastic waste; radiation contamination; thermal pollution; water pollution; ocean pollution; acid precipitation		K2, K4
	Waste Management ; e-waste management; hazardous waste; solid waste management		K2, K3
	Environmental Issues – Indian Himalayan issues; sand mining; wildlife deaths; human-animal conflict; genetically engineered trees;		K4, K5
Unit 4: Biodiversity and Conservation, Indian Biodiversity			
	Basics of Biodiversity – Types (genetic, species, ecosystem diversity); scales of biodiversity assessment (alpha, beta, gamma); methods for quantifying biodiversity;		K1, K2

4	Threats to Biodiversity – Factors posing risks to biodiversity (habitat loss, fragmentation, poaching, invasive species, climate change); disappearance of species; categories and reasons behind species disappearance; Red Data Book; IUCN Red List categories		K2, K4
	Conservation Initiatives – National initiatives Conservation: *in-situ* (national parks, biosphere reserves), *ex-situ* (zoos, gene banks, Wildlife Sanctuaries) Global initiatives (Man and Biosphere Programme, Biosphere Reserves, Biodiversity Hotspots, World Heritage Sites)		K2, K4
	Indian Biodiversity – Bio-geographical classification of India; Conservation Efforts – Project Tiger, Project Leopard, Project Elephant, Crocodile Conservation Project; Captive Breeding;		K2, K4
Unit 5: Climate Change, Environmental Policies, and Acts			
5	Basic Understandings of Climate Change – Greenhouse gases and greenhouse effect; global warming; El Niño & La Niña, and its potential; ozone depletion; ocean acidification and rising sea level; carbon mitigation strategies (carbon sequestration, carbon credit, carbon tax; carbon footprint)		K2, K4
	Climate Change Organizations – IPCC and IPCC reports; Kyoto Protocol and other developments; Green Economy;		K2, K4
	Environmental Acts and Policies – Wildlife Protection Act (WPA) 1972; Environment Protection Act (EPA) 1986; National Forest Policy, 1988; Coastal Regulation Zone (CRZ); Wetland Rules 2010; National Green Tribunal (NGT); Ozone Depleting Substances Rules		K2, K4
	Waste Management Rules and Environmental Conventions –E-Waste Management Rules, 2016; Plastic Waste Management (PWM) Rules, 2016; Ramsar Convention, CITES, IUCN, Stockholm Convention,		K2, K4
	TOTAL HOURS		

On the successful completion of the course the Learning Outcomes are

1. Understand habitat, niche, population growth curves, regulation, life history strategies, and metapopulation dynamics.
2. Comprehend community structure, ecological succession, ecosystem functions, and biogeographical zones of India.
3. Grasp species interactions, identify pollution types, and propose waste management strategies.
4. Recognize biodiversity levels, threats, conservation initiatives including in-situ and ex-situ methods, and Indian biodiversity.
5. Understand climate change causes, impacts, mitigation strategies, and the role of IPCC and UNFCCC.
6. Appreciate environmental acts, waste management rules, and international conventions such as CITES and Ramsar.

Reference Books

1.	**Odum,Eugene P.** 2004. Fundamentals of Ecology. Brooks Cole; 5th edition. 624 pages.
2.	**Chapman, J.L. & Reiss, M.J.** 1992. Ecology: Principles and applications. Cambridge Univ. Press. 294 pages.
3.	**Cunningham, W.P. & Cunningham, M.A.** 2003. Principles of environmental science, inquiry and applications. Tata McGraw-Hill Publ. Co. Ltd. 424 pages.
4.	**Kemp, David D.** 1994. Global environmental issues: A climatological approach. Routledge, London. 224 pages.
5.	**Klarke, G.L.** 1954. Elements of ecology. John Wiley & Sons, Inc. 560 pages.

Textbooks

6.	**Rastogi, V.B. & Jayaraj, M.S.** Animal ecology and distribution of animals.
7.	**Sharma, P.D.** 2000. Ecology and environment. Rastogi Publ. 660 pages.
8.	**Purohit, S.S. & Agrawal, A.K.** 2004. Environmental pollution: causes, effects and control. 601 pages.
9.	Environmental Ecology, Bio diversity, Climate Change & Disaster Management; 3rd Edition By Ravi P Agrahari© 2023

Online Resources (Free or Accessible)

10.	**https://vajiramandravi.com/upsc-exam/environment-and-ecology-notes/**
11.	**Fundamental biology and concepts: Use the Khan Academy Ecology Archive**
12.	**Vedantu Ecology Revision Notes**
13.	**Testbook Ecology & Biology Guide**
14.	**https://egyankosh.ac.in/bitstream/123456789/85688/1/Block-2.pdf**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	2	1	1	1	2	1	2	**1.6**
CO2	3	3	2	2	2	2	1	2	**2.1**
CO3	3	3	2	2	1	3	3	2	**2.4**
CO4	3	3	2	2	1	3	1	2	**2.1**
CO5	3	3	1	2	2	3	2	2	**2.3**
CO6	3	3	1	2	1	3	1	2	**2.0**
Average	**3.0**	**2.8**	**1.5**	**1.8**	**1.3**	**2.7**	**1.5**	**2.0**	**2.078**

Final Overall Matrix Score = 2.078/3.00=69.26%

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M.Sc. Zoology Course - SEMESTER-IV
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LAB COURSE IV-Evolution and Ecology

Core Paper-	**Credits:5**	**Paper Code:**
Total Contact Hours:72		**Weekly Contact Hours: 6**

CO No.	**Course Outcome (CO)**	**K-Level**	**PO**
CO1	Demonstrate simulation-based understanding of microevolutionary forces (natural selection and genetic drift) and apply Hardy-Weinberg equilibrium calculations to determine if a population is evolving.	K3	PO1, PO3
CO2	Identify and correlate index fossils, transitional fossils (Archaeopteryx), and hominid skulls with the geological time scale to interpret evolutionary lineages and transitional forms.	K4	PO1, PO4
CO3	Construct cladograms using morphological character matrices and compare molecular sequence data (cytochrome c, hemoglobin) to infer phylogenetic relationships among vertebrate taxa.	K5	PO1, PO5
CO4	Perform quantitative analyses of abiotic ecological parameters (Dissolved Oxygen by Winkler's method, soil salinity by Mohr's titration, soil phosphorus by Olsen's method) using standard laboratory protocols.	K3	PO3, PO6
CO5	Calculate species diversity indices (Simpson's and Shannon-Wiener), construct ecological pyramids, and analyze food web dynamics to evaluate community structure and energy flow.	K5	PO2, PO6
CO6	Assess biodiversity conservation status using IUCN Red List categories, identify Indian biodiversity hotspots, and apply field sampling techniques (quadrat, transect) for population estimation.	K4	PO6, PO8

SECTION A – MAJOR PRACTICALS

S.No.	Practical Title	Organism/Method	Key Observation Points	Evaluation Basis
1	Natural selection simulation	Beads/Models	Simulate camouflage; count survival; plot directional/stabilizing trends.	Graph + Interpretation
2	Genetic drift simulation	Beads/Models	Small population bottleneck; record random allele frequency fluctuations.	Graph + Interpretation
3	Study of index fossils	Models/Charts	Identify fossils; map to geological time scale (Cambrian-Cretaceous).	Labelling + Correlation
4	Cladogram construction	Morphological Data	Construct using character matrix; define synapomorphies/monophyletic groups.	Diagram + Analysis
5	Dissolved Oxygen (DO)	Winkler's Method	Titration (Na-thiosulfate); endpoint detection; mg/L calculation.	Calculation + Result
6	Soil Salinity	Mohr's Method	Titrate soil extract (AgNO3); identify endpoint; determine chloride content.	Procedure + Result
7	Soil Phosphorus	Olsen/Bray Method	Extract P; color development (molybdate); spectrophotometric readout at 882 nm.	Calculation + Analysis

SECTION B – MINOR PRACTICALS

S.No.	Practical Title	Type	Points to Study
1	Hardy-Weinberg	Population Genetics	Calculate allele/genotype frequencies; chi-square

	equilibrium		significance testing.
2	Fossil morphology	Charts	Comparative analysis of fossil structures and adaptive features.
3	Ecological pyramids	Data Analysis	Construct pyramids of biomass, energy, and numbers; analyze energy flow.
4	Species diversity indices	Simpson/Shannon	Calculate H' and D; quantify community structure and ecosystem health.

SECTION C – SPOTTERS (Expanded List)

S.No.	Specimen / Organism	Material Type	Key Diagnostic Features
1-5	Fossils	Charts/Models	Trilobite, Ammonite, Graptolite, Nummulite, Brachiopod identification.
6-10	Evolutionary Evid.	Charts	Archaeopteryx, Peppered Moth, Darwin's Finches, Homologous/Analogous organs.
11-15	Hominin Skulls	Models	Comparison: *A. africanus, H. habilis, H. erectus, Neanderthal, H. sapiens*.
16-20	Field Instruments	Tools	Quadrat, Secchi Disc, Plankton Net, Lux Meter, pH Meter, Anemometer.
21-23	Biogeochemical Cycles	Charts	Nitrogen, Phosphorus, Water Cycles.
24-328	Ecosystem Models	Diagrams	Energy Pyramids, Food Webs, Trophic Levels, Detritus Chain.
29-31	Bio-hotspots/IUCN	Maps	Western Ghats, Indo-Burma, Red List Categories
32-34	Environmental Pollution	Charts	Bioaccumulation, Biomagnification (e.g., DDT), Eutrophication.
35-39	Ecological Adaptations	Charts	**Camouflage-**chameleon; C**oloration** Peppered Moths**-.Special Body Parts-**Anteaters (Tongue); Elephants (large ears)

LEARNING OUTCOME (LO)

LO No.	Learning Outcome (LO)	Corres PondingCO
LO1	Execute bead-based simulations to model allele frequency changes across generations and differentiate between natural selection and genetic drift.	**CO1**
LO2	Perform Winkler's titration, Mohr's chloride titration, and Olsen's colorimetric assay to measure Dissolved Oxygen, soil salinity, and available phosphorus in environmental samples with precision.	**CO4**
LO3	Construct cladograms from character matrices and interpret molecular sequence alignments (cytochrome c, hemoglobin) to infer evolutionary relationships and divergence times.	**CO3**
LO4	Calculate Simpson's and Shannon-Wiener diversity indices and draw ecological pyramids of numbers, biomass, and energy from given trophic data.	**CO5**
LO5	Identify and date hominid fossils (Australopithecus, Homo habilis, Homo erectus, Neanderthal, Homo sapiens) and correlate anatomical changes with locomotory and cultural evolution.	**CO2**
LO6	Operate field equipment (Secchi disc, DO meter, anemometer, plankton net, pH meter) and apply line/point transect methods to assess aquatic and terrestrial ecosystem health.	**CO4, CO6**

PO–CO Correlation Strength Matrix *Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

Course Outcomes	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**AVE.**
CO1 (Microevolution simulations & H-W)	3	2	3	2	2	2	2	3	**2.38**
CO2 (Fossils, time scale & hominids)	3	2	1	3	1	2	2	2	**2.00**
CO3 (Cladograms & molecular phylogenetics)	3	3	1	2	3	2	2	1	**2.13**
CO4 (Abiotic parameter quantification)	2	2	3	2	2	3	2	1	**2.13**
CO5 (Diversity indices, pyramids & food webs)	2	3	2	2	1	3	1	1	**1.88**
CO6 (Conservation, hotspots & field sampling)	2	2	2	1	1	3	2	2	**1.88**
AVERAGE	**2.50**	**2.33**	**2.00**	**2.00**	**1.67**	**2.50**	**1.83**	**1.67**	**2.06**

Final Overall Matrix Score = 2.0625/3.00=68.75%

பெரியார் பல்கலைக்கழகம்

PERIYAR UNIVERSITY

DEPARTMENT OF ZOOLOGY

Salem-636011, Tamil Nadu

M.Sc. Zoology Course - SEMESTER-IV

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

PROJECT WORK AND VIVA VOCE

Project-	**Credits:6**	**Paper Code:**
Total Contact Hours:96		**Weekly Contact Hours: 8**

Course Objectives:
PG project emphasizes independent research, scientific inquiry, data-driven conclusions, and contribution to the existing body of knowledge**.**

Pre-requisite Knowledge: PG project demands a higher degree of independence, analytical rigor, and scientific maturity**.** Foundational Theoretical Knowledge, Core Practical Laboratory Skills, Analytical & Computational Skills, Safety & Ethical Knowledge, Documentation & Communication Skills, Professional & Soft Skills are required to conduct research project

Objective Category	Objective Statement	Bloom's Level	Related PO
Research & Inquiry	Formulate a research question/hypothesis based on a thorough literature review, and design a robust experimental/analytical methodology to address it.	K4, K6	PO1, PO2
Practical Execution	Execute experiments, field studies, or computational analyses with precision, reproducibility, and adherence to standard protocols, while troubleshooting challenges independently.	K3, K4	PO3, PO4
Data Analysis	Analyze, interpret, and synthesize collected data using appropriate statistical, bioinformatics, or analytical tools to draw meaningful and valid conclusions.	K4, K5	PO2, PO7
Scientific Communication	Communicate research findings effectively through a comprehensive written thesis, a structured oral presentation, and/or a research paper, adhering to scientific writing standards.	K4, K6	PO7
Professional & Ethical Conduct	Demonstrate professional responsibility, scientific integrity, adherence to biosafety/ethical guidelines, and effective time and project management throughout the research process.	K3, K5	PO5, PO6
Lifelong Learning	Identify gaps in knowledge, evaluate the limitations of the study, and propose future research directions, fostering a mindset of continuous learning and inquiry.	K5, K6	PO8

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

Objective Category - PO–CO Correlation Strength Matrix*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

Objective Category	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Ave.
Research & Inquiry	3	3	2	1	1	1	2	3	**2.00**
Practical Execution	3	2	3	3	3	2	1	2	**2.38**
Data Analysis	3	3	3	3	1	1	3	3	**2.50**
Scientific Communication	2	2	1	1	1	1	3	3	**1.75**
Professional & Ethical Conduct	2	2	2	2	3	3	2	3	**2.38**
Lifelong Learning	3	3	2	1	1	1	2	3	**2.00**
Average	**2.67**	**2.50**	**2.17**	**1.83**	**1.67**	**1.50**	**2.17**	**2.83**	**2.16**

Final Overall Matrix Score = 2.16/3.00=72.0%

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M.Sc. Zoology Course - SEMESTER-IV

(This syllabus is applicable to the students who are admitted on or after 2026-2027academic year onwards)

APICULTURE

Elective Paper-	**Credits:3**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

Course Outcomes (COs) for APICULTURE

On the successful completion of the course, student will be able to:		
	Course Outcome	**K Level**
CO1	Define apiculture, classify honey bee species, describe life cycle, behavior, and social organization of bee colony.	K2, K4
CO2	Compare beekeeping systems, identify tools and equipment, describe types of hives, and select appropriate site for apiary.	K2, K3
CO3	Identify bee enemies and diseases, explain preventive and control measures, and analyze colony collapse disorder (CCD).	K4, K5
CO4	Describe bee products (honey, royal jelly, propolis, pollen, bee venom), their harvesting, processing, packaging, and marketing.	K3, K4
CO5	Explain the role of CBRTI, KVIC, NBB, and other organizations in apiculture development.	K2, K3
CO6	Analyze the scope of apiculture as an entrepreneurial venture, calculate economics, and identify government schemes and subsidies.	K3, K4

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

Pre-requisite knowledge: Fundamental knowledge of bee biology, local flora, and hive management to ensure colony health and profitable yields.

Unit	**Topic Name**	**Hrs.**	**K. level**
Unit 1: Introduction to Apiculture and Honey Bee Biology			
1	Introduction to Apiculture – definition, history, and scope		K1, K2
	Classification and types of honey bees – major species (Apis dorsata – rock bee, Apis cerana – Indian hive bee, Apis mellifera – European/Italian bee, Apis florea – dwarf bee, Trigona – stingless bee)		K1, K2
	Life cycle of honey bees – stages (egg, larva, pupa, adult); duration of each stage for queen, worker, and drone		K2, K3
	Social organization of bee colony – caste system (queen, worker, drone) – morphology, functions, and division of labor		K2, K4
Unit 2: Bee-Keeping Systems, Equipment, and Site Selection			
2	Bee-keeping system – types (sedentary/migratory, traditional vs. modern); seasonal management		K2, K3
	Tools and equipment needed for bee keeping – hive tool, bee brush, smoker, queen excluder, feeder, honey extractor (manual and electric), protective gear (gloves, veil, suit)		K1, K2
	Types of bee hives – traditional (log hive, mud hive, wall hive) and modern (Langstroth hive, Newton hive, Dadant hive) – structure and functional features		K2, K4
	Criteria for site selection for apiculture – factors affecting apiary location (availability of bee flora, water source, shelter, protection from wind, absence of pesticides, distance from human habitation, roads)		K3, K4
Unit 3: Pest and Disease Management in Apiculture			
3	Identification and characteristics of different bee enemies – wax moth (Galleria mellonella), varroa mite (Varroa destructor), acarine mite (Acarapis woodi), ants, wasps, birds, lizards, bears		K1, K2
	Preventive measures to be taken against bee enemies – integrated pest management (IPM) strategies (cultural, mechanical, biological, chemical control)		K3, K4
	Diseases affecting honey bees and their control measures – bacterial (American foulbrood – Paenibacillus larvae, European foulbrood – Melissococcus plutonius), fungal (Nosema disease – Nosema apis, chalkbrood – Ascosphaera apis), viral (sacbrood, deformed wing virus)		K2, K4
	Colony collapse disorder (CCD) – definition, causes (pesticides – neonicotinoids,		K4, K5

	pathogens, parasites, nutritional stress, habitat loss), symptoms, and management strategies		
Unit 4: Bee Products and Value Addition			
4	Honey – types (monofloral, multifloral), composition (fructose, glucose, water, enzymes, minerals, vitamins), harvesting (super removal, bee escape, brushing), extraction (uncapping, centrifugal extraction), processing (filtering, settling, pasteurization, creaming), packaging and storage		K3, K4
	Royal jelly – composition, harvesting (grafting method), uses (health supplement, cosmetics), storage		K2, K3
	Propolis – composition, harvesting (scraping from hive), uses (antimicrobial, wound healing, immune booster), processing		K2, K3
	Harvesting, Processing, Packaging and Marketing of bee products – value addition, quality standards (FSSAI, AGMARK, Codex Alimentarius), branding, labeling, certification (organic, GI tag), market channels (local, online, export)		K3, K5
Unit 5: Apiculture Industry, Training Institutes, and Entrepreneurship			
5	Apiculture industry around the world – major honey producing countries (China, Turkey, Iran, India, USA), export and import trends, global honey market		K1, K2
	Role of Central Bee Research & Training Institute (CBRTI), Pune – history, objectives, research activities, training programmes, extension services, National Bee Board (NBB),		K2, K3
	Apiculture as an Entrepreneurial venture – scope, opportunities, challenges		K4, K5
	Economics of apiculture – cost of establishment (hives, bees, equipment, land), recurring costs (feed, medicines, labour, maintenance), income (honey, wax, propolis, royal jelly, pollination services), profit calculation, break-even analysis, government subsidies (NABARD, KVIC, NHM, MIDH)		K3, K4
	TOTAL HOURS	48	

On the successful completion of the course the Learning Outcomes are

1. Define and understand apiculture, classify honey bee species, grasp life cycle, behavioural patterns, and social organization.

2. Comprehend beekeeping systems, identify tools and hives such as Langstroth, and recognize appropriate apiary sites.

3. Understand bee enemies and diseases, grasp integrated pest management, and analyze colony collapse disorder.

4. Recognize bee products including honey, royal jelly, propolis, pollen, and venom, along with quality standards and marketing channels.

5. Appreciate the role of CBRTI, KVIC, NBB, and other organizations in apiculture development.

6. Perceive apiculture as an entrepreneurial venture, calculate economics, and identify government schemes.

Reference Books

1.	Abrol, D. P. (2013). Beekeeping: A comprehensive guide to bees and beekeeping. Scientific Publishers.
2.	Atwal, A. S. (2000). Beekeeping in India. Oxford & IBH Publishing.
3.	Bonney, R. E. (2018). Beekeeping: A practical guide (Revised ed.). Storey Publishing.
4.	Crane, E. (1990). Bees and beekeeping: Science, practice and world resources. Cornell University Press.
5.	Dadant, C. P. (2012). First lessons in beekeeping. Dadant & Sons.
6.	Graham, J. M. (Ed.). (2015). The hive and the honey bee. Dadant & Sons.
7.	Root, A. I., & Root, E. R. (2014). The ABC and XYZ of bee culture: An encyclopedia pertaining to the scientific and practical culture of honey bees. Read Books Ltd.
8.	Seeley, T. D. (2010). Honeybee democracy. Princeton University Press.
9.	Tautz, J. (2008). The buzz about bees: Biology of a superorganism. Springer.
10.	Winston, M. L. (1987). The biology of the honey bee. Harvard University Press.
11.	**Online Resources (Free or Accessible)**
12.	**https://www.nitiforstates.gov.in/public-assets/Policy/policy_files/SNC498C000145.pdf**
13.	**https://research.wsu.edu/news/wsu-launches-bilingual-video-series-to-help-beekeepers-improve-colony-health**
14.	**https://www.uaex.uada.edu/farm-ranch/special-programs/beekeeping/beekeepingshortcourse.aspx?**
15.	**https://agritech.tnau.ac.in/apiculture/fe_apiculture_home.html?utm**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average

CO1	3	2	2	3	3	2	3	2	**2.50**
CO2	3	2	3	2	2	1	1	2	**2.00**
CO3	3	3	2	2	2	2	2	3	**2.38**
CO4	3	2	3	2	1	1	2	2	**2.00**
CO5	3	2	1	2	1	2	2	2	**1.88**
CO6	3	3	2	3	2	2	1	3	**2.38**
Average	**3.00**	**2.33**	**2.17**	**2.33**	**1.83**	**1.67**	**1.83**	**2.33**	**2.1875**

Final Overall Matrix Score = 2.188/3.00=7.29%

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M.Sc. Zoology Course – SEMESTER-IV
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ANIMAL BIOTECHNOLOGY

Elective Paper-	**Credits:3**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

Course Outcomes (Cos) for Animal Biotechnology

On the successful completion of the course,studentwill beable to:		
Cos	**Course Outcome**	**K Level**
CO1	Explain the principles of genetic engineering, gene transfer methods, and isolation of nucleic acids.	K2, K4
CO2	Set up and maintain animal cell cultures, including primary culture, cell lines, cryopreservation, and scale-up.	K3, K4
CO3	Explain stem cell biology, tissue engineering principles, and assisted reproductive technologies in animals.	K2, K4
CO4	Describe the production and applications of transgenic animals, knockout models, and reproductive cloning.	K2, K4
CO5	Apply molecular diagnostic techniques (PCR, blotting, DNA barcoding) and explain recombinant vaccine production.	K3, K4
CO6	Analyze biopharmaceutical production, gene therapy strategies, and ethical issues in animal biotechnology.	K4, K5

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

Pre-requisite knowledge: Fundamental understanding of cellular processes, DNA manipulation, and protein synthesis required to work with animal genomes

Unit.	Topic Name	Hrs.	K. level
Unit 1: Introduction to Animal Biotechnology and Genetic Engineering			
Unit 1	Definition; Basic principles of genetic engineering – restriction enzymes (types and functions), DNA ligase, alkaline phosphatase, other modifying enzymes		K1, K2
	Vectors in animal genetic engineering – plasmids, cosmids, phagemids; Yeast Artificial Chromosomes (YACs), Bacterial Artificial Chromosomes (BACs); shuttle vectors		K2, K3
	Gene transfer methods in animals – electroporation, microinjection, biolistic particle delivery (gene gun), lipofection, retrovirus-mediated gene transfer.		K2, K4
	Isolation and purification of nucleic acids – DNA extraction,agarose gel electrophoresis		K3, K4
Unit 2: Animal Cell Culture Technology			
Unit 2	Introduction to animal cell culture-Types of culture media – natural media (plasma, serum, tissue extracts), synthetic media (MEM, DMEM,); serum (FBS) and serum-free media; chemically defined media.		K2, K4
	Primary cell culture and cell lines – primary culture,subculture, established cell lines (continuous cell lines), types of cell lines (finite vs. continuous,		K2, K3
	Maintenance and preservation of cell lines – cryopreservation (freezing medium, slow freezing, liquid nitrogen storage), thawing, revival of frozen cells;		K3, K4
Unit 3: Stem Cell Technology and Reproductive Biotechnology			
Unit-3	Stem cells – definition, properties (self-renewal, differentiation); types – embryonic stem cells (ESCs), adult stem cells (hematopoietic, mesenchymal, neural),		K2, K4
	Applications of stem cells – regenerative medicine, drug testing, disease modeling, cell-based therapies; ethical issues in stem cell research		K2, K5
	Assisted reproductive technologies (ART) in animals – artificial insemination (AI), superovulation, multiple ovulation and embryo transfer (MOET), in vitro fertilization (IVF), embryo splitting, embryo sexing, cryopreservation of sperm and embryos		K3, K4
Unit 4: Transgenic Animals and Biopharming			
	Transgenic animals – definition, strategies for production (microinjection of DNA		K2, K4

Unit-4	into pronucleus, retroviral vectors, embryonic stem cell method, SCNT cloning); transgenic mice, fish,		
	Applications of transgenic animals –production of human therapeutic proteins in milk, egg, blood),		K3, K5
	Gene knockout and knock-in technology – homologous recombination, CRISPR-Cas9 gene editing; applications in creating disease models and studying gene function		K4, K5
Unit 5: Applications of Animal Biotechnology – Diagnostics, Therapeutics			
Unit-5	Molecular diagnostics for animal diseases – polymerase chain reaction (PCR – conventional, RT-PCR), nucleic acid hybridization (Southern, Northern, Western blotting), DNA probes.		K3, K4
	DNA barcoding and DNA fingerprinting – principles, methodology, applications in species identification, wildlife forensics, conservation genetics, food adulteration detection		K2, K4
	Biopharmaceutical products from animal cell culture – therapeutic proteins blood clotting factors, Factor VIII, hormones -insulin, interferons, interleukins		K2, K4
	Gene therapy – definition, types (somatic vs. germline gene therapy), applications in treating genetic disorders (SCID, hemophilia, cystic fibrosis		K4, K5
	TOTAL HOURS	48	

On the successful completion of the course the Learning Outcomes are

1. Comprehend genetic engineering principles including restriction enzymes, vectors, gene transfer methods, and nucleic acid isolation.

2. Grasp how to set up and maintain animal cell cultures covering primary culture, cell lines, subculturing, cryopreservation, and revival.

3. Understand stem cell biology, tissue engineering, assisted reproductive technologies (AI, IVF, embryo splitting), and ethical issues.

4. Recognize transgenic animal production, gene knockout and knock-in using CRISPR-Cas9, and reproductive cloning.

5. Appreciate molecular diagnostic techniques such as PCR, blotting, DNA barcoding, and fingerprinting, and comprehend recombinant vaccines.

6. Perceive biopharmaceutical production, gene therapy strategies, and ethical issues in animal biotechnology.

Reference Books

1.	*Animal Cell Culture: A Practical Approach*R. Ian FreshneyWiley-Blackwell
2.	Principles of Gene Manipulation and GenomicsS. B. Primrose & R. M. TwymanBlackwell Publishing
3.	Transgenic Animal Technology: A Laboratory HandbookCarl A. PinkertAcademic Press / Elsevier
4.	Stem Cells: Scientific Progress and Future Research Directions National Institutes of Health (NIH) NIH Publication
5. Textbooks	
6.	Dubey, R. C. (2025). A textbook of biotechnology (6th ed.). S. Chand & Company Ltd.
7.	Satyanarayana, U. (2020). Biotechnology. Books & Allied Pvt. Ltd.
8.	Concepts In Biotechnology 1St Edtion Biotechnology University Press 2004
9.	Elements Of Biotechnology 1St Edtion Biotechnology RasTogiPub.Meerut 2007
10. Online Resources (Free or Accessible)	
11.	**Tamil Nadu Veterinary and Animal Sciences University (TANUVAS) University Portal https://tanuvas.ac.in**
12.	**NPTEL – Animal Biotechnology Free Online Course https://nptel.ac.in (Search: Animal Biotechnology)**
13.	**ICAR-National Bureau of Animal Genetic Resources (NBAGR) Research Institute https://nbagr.icar.gov.in**
14.	**Addgene – CRISPR Guide Educational Resourcehttps://www.addgene.org/guides/crispr**
15.	**The Node – Development and Stem Cell Biology Educational Resourcehttps://thenode.biologists.com**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	Average
CO1	3	3	2	1	1	1	2	2	**1.9**
CO2	3	2	3	2	1	1	1	2	**1.9**
CO3	3	2	2	1	1	2	2	2	**1.9**
CO4	3	3	1	2	1	2	2	2	**2.0**

CO5	3	3	3	2	2	1	3	2	**2.4**
CO6	3	3	1	2	1	2	3	3	**2.3**
Average	**3.0**	**2.7**	**2.0**	**1.7**	**1.2**	**1.5**	**2.2**	**2.2**	**2.064**

Final Overall Matrix Score = 2.064/3.00=68.83%

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RESEARCH METHODOLOGY

Core Paper-	**Credits:3**	**Paper Code:**
Total Contact Hours:48		**Weekly Contact Hours: 4**

Course Outcomes (COs) for Research Methodology

On the successful completion of the course, student will be able to:

COs	Course Outcome	K Level
CO1	Define research, explain characteristics of good research, identify research problems, formulate hypotheses, and organize literature reviews.	**K2, K3**
CO2	Classify types of research (pure/applied, qualitative/quantitative), describe research designs (exploratory, descriptive, causal), and explain research terminologies (case reports, cohort studies, RCTs, preclinical methods).	**K2, K4**
CO3	Write scientific papers using IMRAD format, prepare thesis/dissertations, apply different citation styles (APA, MLA, Vancouver, Harvard), and explain the importance of academic events (workshops, seminars, conferences).	**K2, K3**
CO4	Explain research ethics, identify forms of plagiarism, use similarity checking software (Turnitin, iThenticate), prepare research proposals, and identify Indian research funding agencies.	**K2, K4**
CO5	Use statistical software (SPSS, MS Excel, R) for data analysis, create tables and graphs, and use reference management software (Zotero, Mendeley).	**K2, K3**
CO6	Explain the role of artificial intelligence (AI) in research and apply ICT tools for effective research management.	**K2, K4**

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

Pre-requisite knowledge: Foundational knowledge in four main areas: scientific logic, research design, data collection techniques, and data analysis with ethics.

Unit	Topic Name	Hrs.	K. level
Unit 1: Foundations of Research – Concepts, Problems, and Hypotheses			
1	The concept of research, characteristics of good research, Application of Research		K1, K2
	Meaning and sources of Research problem, characteristics of good Research problem		K2, K3
	Research process, outcomes, application of Research		K2, K3
	Meaning and types of Research hypothesis, Importance of Review of Literature		K2, K4
	Organizing the Review of Literature		K2, K3
Unit 2: Research Classifications, Designs, and Terminologies			
2	Types of research – pure (basic, fundamental) and applied research, Interdisciplinary; qualitative and quantitative		K2, K4
	Research Design – Meaning, need, types of research design – Exploratory, Descriptive, Casual research Design		K2, K4
	Components of research design, and Features of good Research design		K2, K4
	Research Designs and terminologies: 1. Case reports 2. Case Series 3. Cross sectional and longitudinal 4. Cohort studies 5. Clinical trials (Randomized controlled trials) 6. Preclinical Methods (In-silico, In-vitro, In situ and In-vivo)		K2, K4
Unit 3: Scientific Writing – Structure, Thesis, and Referencing			
3	Structure of a scientific paper: IMRAD format (Introduction, Methods, Results, and Discussion); title, abstract, keywords, acknowledgements, references; supplementary materials		K2, K3
	Thesis and dissertations – components of thesis and dissertations		K2, K3
	Referencing styles and bibliography – citation styles (APA, MLM, Vancouver, Harvard, Nature)		K2, K3
	Meaning and importance of workshop, seminar, conference, symposium etc. in research		K2, K3
	Structure of a scientific paper: IMRAD format (Introduction, Methods, Results, and		K2, K3

	Discussion); title, abstract, keywords, acknowledgements, references; supplementary materials		
Unit 4: Research Ethics, Plagiarism, and Funding Agencies			
4	Ethics in Research – Plagiarism – Definition, different forms, consequences, unintentional plagiarism, copyright infringement, collaborative work		K2, K4
	Similarity checking – Turnitin, iThenticate; Citation and acknowledgement , impact factor and h index.		K2, K3
	Qualities of good Researcher		K2, K3
	Research Project Types (Major and Minor) and Proposal format		K3, K4
	Indian Research Funding Agencies		K1, K2
Unit 5: Computational Tools for Research – Statistics, Reference Management, and AI			
5	Commonly used Statistical softwares, SPSS, MS Excel and R		K2, K3
	ICT Tools for Research: Role of computers, Software – maintenance, reference management software (Zotero, Mendeley)		K2, K3
	Tabulation and graphical presentation of research data software tools		K2, K3
	Artificial intelligence (AI) roles in Research		K2, K4
	TOTAL HOURS	48	

On the successful completion of the course the Learning Outcomes are

Understand research, identify research problems, formulate hypotheses, and organize literature reviews.

1. Comprehend types of research, describe research designs including RCTs and cohort studies, and explain research terminologies.

2. Grasp scientific writing using the IMRAD format, prepare theses, apply citation styles, and understand academic events.

3. Recognize research ethics, types of plagiarism, use similarity checking software, prepare proposals, and identify funding agencies.

4. Understand statistical software including SPSS and R, create tables and graphs, use reference managers, and comprehend ICT tools.

5. Appreciate the role of AI in research covering literature search, data analysis, and drafting, along with ethical considerations.

Reference Books

1.	Donald H. McBurney, Research Methods, 5th edition, Thomson Learning, ISBN: 81-315- 0047-0, 2006
2.	Research Methodology, Mukul Gupta, Deepa Gupta – PHI Learning Private Ltd.,
3.	Thesis and Assignment Writing, J. Anderson, Wiley Eastern Ltd., 1997.
4.	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5.	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6.	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.

Textbooks

7.	An introduction to Research Methodology; Garg B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002., RBSA Publishers.
8.	Research Methodology: Methods and Techniques ,Kothari C.R., 1990.. New Age International.
9.	Research Methodology; Sinha S.C. and Dhiman, A.K., 2002. Ess Publications. 2 volumes.
10.	Research Methods: the concise knowledge base; Trochim W.M.K., 2005. Atomic Dog Publishing.

Online Resources (Free or Accessible)

11.	**https://epgp.inflibnet.ac.in/?utm**
12.	**https://ocw.mit.edu/?utm**
13.	**https://www.coursera.org/?utm**

PO–CO Correlation Strength Matrix

*Strength: **3** = Strong, **2** = Moderate, **1** = Weak*

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**Average**
CO1	3	3	1	3	1	1	1	2	**1.9**
CO2	3	3	1	3	1	1	1	2	**1.9**
CO3	3	2	1	3	2	1	1	3	**2.0**
CO4	3	3	1	3	1	2	1	2	**2.0**
CO5	3	3	2	3	3	1	1	3	**2.4**
CO6	3	3	1	3	3	1	1	3	**2.3**
Average	**3.0**	**2.8**	**1.2**	**3.0**	**1.8**	**1.2**	**1.0**	**2.5**	**2.071**

Final Overall Matrix Score = 2.071/3.00=69.03%

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EXTENTION ACTIVITY

Core Paper-	**Credits:1**	**Paper Code:**
Total Contact Hours:		**Weekly Contact Hours:**

Types of Extension Activities

Activity Type	Examples
Community Outreach Projects	Village/school adoption, health awareness camps, environmental conservation, digital literacy campaigns
Civic Engagement Programs	NCC, NSS, Youth Red Cross (YRC), blood donation drives
Skill Development Workshops	Entrepreneurial development, women's empowerment, financial literacy, organic farming
Service-Learning Projects	Internships, community-based research, fieldwork projects
Awareness Campaigns	Health and hygiene, legal awareness, gender issues, environmental protection

Assessment of Extension Activities

Assessment Parameter	Weightage
Regularity of Attendance	**10-20%**
Active Participation in Activities/Camps	**30-60%**
Awards/Certificates/Prizes	**5-10%**
Leadership Qualities	**5-10%**
Social Components (Blood Donation, Fine Arts, etc.)	**5-10%**

CURRICULUM DESIGN COMMITTEE		
S.No.	**NAME AND ADDRESS**	**DESIGNATION IN THE BOARD**
1.	**Dr. K.BABU** ASSISTANT PROFESSOR DEPARTMENT OF ZOOLOGY ARIGNAR ARTS COLLEGE NAMAKKAL-637002, PHONE- 9884254401, Email vskbabu@hotmail.com.	**CHAIRMAN**
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