B.Sc. ZOOLOGY

SYLLABUS

(I – VI Semester)

FROM THE ACADEMIC YEAR

2024-2025

Contents

TANSCHE REGULATIONS ON LEARNING OUTCOMES-BASED CURRICULUM FRAMEWORK GUIDELINES BASED REGULATIONS FOR UNDER GRADUATE PROGRAMME	
Programme:	**B.Sc., Zoology**
Programme Code:	
Duration:	**UG - 3 Years**
Programme Outcomes:	**PO1: Disciplinary knowledge:** Capable of demonstrating comprehensive knowledge and understanding of one or more disciplines that form a part of an undergraduate Programme of study **PO2: Communication Skills:** Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups. **PO3: Critical thinking:** Capability to apply analytic thought to a body of knowledge; analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories by following scientific approach to knowledge development. **PO4: Problem solving: Capacity** to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

	PO5: Analytical reasoning: Ability to evaluate the reliability and relevance of evidence; identify logical flaws and holes in the arguments of others; analyze and synthesize data from a variety of sources; draw valid conclusions and support them with evidence and examples, and addressing opposing viewpoints. **PO6: Research-related skills**: A sense of inquiry and capability for asking relevant/appropriate questions, problem arising, synthesising and articulating; Ability to recognise cause-and-effect relationships, define problems, formulate hypotheses, test hypotheses, analyse, interpret and draw conclusions from data, establish hypotheses, predict cause-and-effect relationships; ability to plan, execute and report the results of an experiment or investigation **PO7: Cooperation/Team work:** Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team **PO8: Scientific reasoning**: Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective. **PO9: Reflective thinking**: Critical sensibility to lived experiences, with self-awareness and reflexivity of both self and society. **PO10: Information/digital literacy:** Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data. **PO11: Self-directed learning**: Ability to work independently, identify appropriate resources required for a project, and manage a project through to completion. **PO12: Multicultural competence:** Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups. **PO13: Moral and ethical awareness/reasoning**: Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, not adhering to intellectual property rights; appreciating environmental and sustainability issues; and adopting objective, unbiased and truthful actions in all aspects of work. **PO 14: Leadership readiness/qualities:** Capability for mapping out the tasks of a team or an organization, and setting direction, formulating an inspiring vision, building a team who can help

	achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way. **PO 15: Lifelong learning:** Ability to acquire knowledge and skills, including, learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Specific Outcomes:	**PSO1 – Placement:** To prepare the students who will demonstrate respectful engagement with others' ideas, behaviors, beliefs and apply diverse frames of reference to decisions and actions. **PSO 2 - Entrepreneur:** To create effective entrepreneurs by enhancing their critical thinking, problem solving, decision making and leadership skill that will facilitate startups and high potential organizations **PSO3 – Research and Development:** Design and implement HR systems and practices grounded in research that comply with employment laws, leading the organization towards growth and development. **PSO4 – Contribution to Business World:** To produce employable, ethical and innovative professionals to sustain in the dynamic business world. **PSO 5 – Contribution to the Society:** To contribute to the development of the society by collaborating with stakeholders for mutual benefit.

Credit Distribution for UG Programme (2023-2024)

Sem-1	C	H	Sem-II	C	H	Sem-III	C	H	Sem-IV	C	H	Sem- V	C	H	Sem-VI	C	H
Part-1: **Tamil /Language**	**3**	**6**	Part-1: **Tamil /Language**	**3**	**6**	Part-1**:** **Tamil /Language**	**3**	**6**	Part-1: **Tamil /Language**	**3**	**6**	Part-3: **5.1 Core Course- CC IX**	**4**	**5**	Part-3: **6.1 Core Course- CC XIII**	**4**	**6**
Part-2: **English**	**3**	**6**	Part-2: **English**	**3**	**4**	Part-2**:** **English**	**3**	**6**	Part-2**:** **English**	**3**	**6**	Part-3: **5.2 Core Course- CC X**	**4**	**5**	Part-3: **6.2 Core Course- CC XIV**	**4**	**6**
Part-3: **1.3 Core Course- CC I**	**5**	**5**	Part-3: **2.3 Core Course- CC III**	**5**	**5**	Part-3: **3.3 Core Course- CC V**	**4**	**4**	Part-3: **4.3 Core Course- CC VII**	**4**	**4**	Part-3: **5.3 Core Course- CC XI (Lab)**	**3**	**4**	Part-3: **6.3 Core Course- CC XV (Lab)**	**3**	**4**
Part-3: **1.4 Core Course- CC II (Lab)**	**3**	**3**	Part-3: **2.4 Core Course- CC IV (Lab)**	**3**	**3**	Part-3: **3.4 Core Course- CC VI (Lab)**	**2**	**2**	Part-3: **4.4 Core Course- CC VIII (Lab)**	**2**	**2**	Part-3: **5.4 Core Course / Project with Viva Voce - CC XII**	**5**	**4**	Part-3: **6.4 Elective VII / Discipline Specific**	**3**	**5**
Part-3: **1.5 Elective I / Discipline Specific**	**5**	**6**	Part-3: **2.5 Elective II / Discipline Specific**	**5**	**6**	Part-3: **3.5 Elective III / Discipline Specific**	**5**	**6**	Part-3: **4.5 Elective IV / Discipline Specific**	**5**	**6**	Part-3: **5.5 Elective V / Discipline Specific**	**3**	**4**	Part-3: **6.5 Elective VIII / Discipline Specific**	**3**	**5**
Part-4: **1.6 Skill Enhancement Course – SEC-1**	**2**	**2**	Part-4: **2.6 Skill Enhancement Course – SEC-2**	**1**	**2**	Part-4: **3.6 Skill Enhancement Course – SEC-4**	**1**	**2**	Part-4: **4.6 Skill Enhancement Course – SEC-5**	**1**	**2**	Part-3: **5.6 Elective VI / Discipline Specific**	**3**	**4**	Part-3: **Elective Lab VI: Elective VII & Elective VIII**	**2**	**2**
Part-4: **1.7 Foundation Course**	**2**	**2**	Part-4: **2.7 Skill Enhancement Course – SEC-3**	**1**	**2**	Part-4: **3.7 Naan Mudhalvan Course-2**	**2**	**2**	Part-4: **4.7 Naan Mudhalvan Course-3**	**2**	**2**	Part-3: **5.7 Elective Lab V: Elective V & Elective VI**	**2**	**2**	Part-5: **6.6 Extension Activity (NSS / NCC / YRC / RRC / Sports / Youth Welfare activities)**	**1**	**-**
												Part-4: **5.8 Internship / Industrial Visit / Field Visit / Knowledge updation activity**	**2**	**-**			
			Part-4: **2.8 Naan Mudhalvan Course-1** *(by English)*	**2**	**2**	Part-4: **3.8 E.V.S**	**2**	**2**	Part-4: **4.8 Value Education**	**2**	**2**	Part-4: **5.8 Naan Mudhalvan Course-4**	**2**	**2**	Part-4: **6.7 Naan Mudhalvan Course-5**	**2**	**2**
	23	**30**		**23**	**30**		**22**	**30**		**22**	**30**		**28**	**30**		**22**	**30**
Total – 140 Credits																	

Choice Based Credit System (CBCS), Learning Outcomes Based Curriculum Framework (LOCF) Guideline Based Credit and Hours Distribution System for all UG courses including Lab Hours

B.Sc Zoology

First Year – Semester-I

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses [in Total]	13	14
Part-4	Skill Enhancement Course SEC-1	2	2
	Foundation Course	2	2
		23	**30**

Semester-II

Part	List of Courses	Credit	No. of Hours
Part-1	Language – Tamil	3	6
Part-2	English	3	4
Part-3	Core Courses & Elective Courses including laboratory [in Total]	13	14
Part-4	Skill Enhancement Course -SEC-2 (Discipline / Subject Specific)	1	2
	Skill Enhancement Course -SEC-3 (Discipline / Subject Specific)	1	2
	Naan Mudhalvan Course-1 *(Handled by English Dept.)*	2	2
		23	**30**

Second Year – Semester-III

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	11	12
Part-4	Skill Enhancement Course -SEC-4 (Entrepreneurial Based)	1	2
	Naan Mudhalvan Course-2	2	2
	E.V.S	2	2
		22	**30**

Semester-IV

Part	List of Courses	Credit	No. of Hours
Part-1	Language - Tamil	3	6
Part-2	English	3	6
Part-3	Core Courses & Elective Courses including laboratory [in Total]	11	12
Part-4	Skill Enhancement Course -SEC-5 (Discipline / Subject Specific)	1	2
	Naan Mudhalvan Course-3	2	2
	Value Education	2	2
		22	**30**

Third Year
Semester-V

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses including Project / Elective Based	26	28
Part-4	Naan Mudhalvan Course-4	2	2
	Internship / Industrial Visit / Field Visit / Knowledge updation activity	2	-
		28	**30**

Semester-VI

Part	List of Courses	Credit	No. of Hours
Part-3	Core Courses including Project / Elective Based & LAB	19	28
Part-4	Extension Activity	1	-
	Naan Mudhalvan Course-5	2	2
		22	**30**

Consolidated Semester wise and Component wise Credit distribution

Parts	Sem I	Sem II	Sem III	Sem IV	Sem V	Sem VI	Total Credits
Part I	3	3	3	3	-	-	12
Part II	3	3	3	3	-	-	12
Part III	13	13	11	11	24	19	91
Part IV	4	4	5	5	4	2	26
Part V	-	-	-	-	-	1	1
Total	23	23	22	22	28	22	**140**

***Part I. II, and Part III components will be separately taken into account for CGPA calculation and classification for the under graduate programme and the other components. IV, V have to be completed during the duration of the programme as per the norms, to be eligible for obtaining the UG degree.**

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

METHODS OF ASSESSMENT	
Remembering (K1)	• The lowest level of questions requires students to recall information from the course content. • Knowledge questions usually require students to identify information in the textbook.
Understanding (K2)	• Understanding of facts and ideas by comprehending organizing, comparing, translating, interpolating and interpreting in their own words. • The questions go beyond simple recall and require students to combine them altogether
Application (K3)	• Students have to solve problems by using/applying a concept learned in the classroom. • Students must use their knowledge to determine a exact response.
Analyze (K4)	• Analyzing the question is one that asks the students to break down something into its component parts. • Analyzing requires students to identify causes or motives and reach conclusions or generalisations.
Evaluate (K5)	• Evaluation requires an individual to make a judgment on something. • Questions to be asked to judge the value of an idea, a character, a work of art, or a solution to a problem. • Students are engaged in decision-making and problem–solving. • Evaluation questions don't have single right answers.
Create (K6)	• The questions of this category challenge students to get engaged in creative and original thinking. • Developing original ideas and problem-solving skills

Highlights of the Revamped Curriculum:

- Student-centric, meeting the demands of industry & society, incorporating industrial components, hands-on training, skill enhancement modules, industrial project, project with viva-voce, exposure to entrepreneurial skills, training for competitive examinations, sustaining the quality of the core components and incorporating application oriented content wherever required.
- The Core subjects include latest developments in the education and scientific front, advanced programming packages allied with the discipline topics, practical training, devising statistical models and algorithms for providing solutions to industry / real life situations. The curriculum also facilitates peer learning with advanced statistical topics in the final semester, catering to the needs of stakeholders with research aptitude.
- The General Studies and Statistics based problem solving skills are included as mandatory components in the 'Training for Competitive Examinations' course at the final semester, a first of its kind.
- The curriculum is designed so as to strengthen the Industry-Academia interface and provide more job opportunities for the students.
- The Statistical Quality Control course is included to expose the students to real life problems and train the students on designing a mathematical model to provide solutions to the industrial problems.
- The Internship during the second year vacation will help the students gain valuable work experience, that connects classroom knowledge to real world experience and to narrow down and focus on the career path.
- Project with viva-voce component in the fifth semester enables the student, application of conceptual knowledge to practical situations. The state of art technologies in conducting and Explain in a scientific and systematic way and arriving at a precise solution is ensured. Such innovative provisions of the industrial training, project and internships will give students an edge over the counterparts in the job market.
- State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature are incorporated as Elective courses, covering conventional topics to the latest DBMS and Computer software for Analytics.

Value additions in the Revamped Curriculum:

Semester	Newly introduced Components	Outcome / Benefits
I	**Foundation Course** To ease the transition of learning from higher secondary to higher education, providing an overview of the pedagogy of learning abstract Statistics and simulating mathematical concepts to real world.	• Instil confidence among students • Create interest for the subject
I, II, III, IV	**Skill Enhancement papers** (Discipline centric / Generic / Entrepreneurial)	• Industry ready graduates • Skilled human resource • Students are equipped with essential skills to make them employable
		• Training on Computing / Computational skills enable the students gain knowledge and exposure on latest computational aspects
		• Data analytical skills will enable students gain internships, apprenticeships, field work involving data collection, compilation, analysis etc.
		• Entrepreneurial skill training will provide an opportunity for independent livelihood • Generates self – employment • Create small scale entrepreneurs • Training to girls leads to women empowerment
		• Discipline centric skill will improve the Technical knowhow of solving real life problems using ICT tools
III, IV, V & VI	Elective papers- An open choice of topics categorized under Generic and Discipline Centric	• Strengthening the domain knowledge • Introducing the stakeholders to the State-of Art techniques from the streams of multi-disciplinary, cross disciplinary and inter disciplinary nature • Students are exposed to Latest topics on Computer Science / IT, that require strong statistical background • Emerging topics in higher education / industry / communication network / health sector etc. are introduced with hands-on-training, facilitates designing of statistical models in the respective sectors
IV	DBMS and Programming skill, Biostatistics, Statistical Quality Control, Official Statistics,	• Exposure to industry moulds students into solution providers • Generates Industry ready graduates

	Operations Research	• Employment opportunities enhanced
II year Vacation activity	Internship / Industrial Training	• Practical training at the Industry/ Banking Sector / Private/ Public sector organizations / Educational institutions, enable the students gain professional experience and also become responsible citizens.
V Semester	Project with Viva – voce	• Self-learning is enhanced • Application of the concept to real situation is conceived resulting in tangible outcome
VI Semester	Introduction of Professional Competency Component / Naan Mudhalvan	• Curriculum design accommodates all category of learners; 'Statistics for Advanced Explain' component will comprise of advanced topics in Statistics and allied fields, for those in the peer group / aspiring researchers; • 'Training for Competitive Examinations' – caters to the needs of the aspirants towards most sought - after services of the nation viz, UPSC, ISS, CDS, NDA, Banking Services, CAT, TNPSC group services, etc.
Extra Credits: **For Advanced Learners / Honors degree**		• To cater to the needs of peer learners / research aspirants

B.SC., ZOOLOGY -TANSCHE SYLLABUS

Induction of Naam Mudhalvan Course in II semester onwards for those joined in the academic year 2023-24. (2023-2026 batch)

First Year Semester – I

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	6
Part-3	Core Course I: **Invertebrata** Core Course II: **Lab on Invertebrata** Elective-I (Generic /Discipline Specific): **Allied Botany I /** **Industrial Fish and Fisheries-I Biology of fish** Lab Course: **Elective-I- Lab on Allied Botany /** **Industrial Fish Fisheries-I Biology of Fish**	5 3 3 2	5 3 4 2
Part-4	Skill Enhancement Course – SEC-I: **Ornamental Fish Farming and Management**	2	2
	Foundation Course: **Introduction to Zoology**	2	2
	Total	**23**	**30**

First Year Semester – II

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	4
Part-3	Core Course III: **Chordata** Core Course IV: **Lab on Chordata** Elective-II (Generic /Discipline Specific): **Allied Botany II /** **Industrial Fish and Fisheries-II Biology of fish** Lab Course: Elective-II- **Lab on Allied Botany II /** **Lab on Industrial Fish Fisheries-II Biology of Fish**	5 3 3 2	5 3 4 2
Part-4	Skill Enhancement Course – SEC-2: **Bio Composting for Entrepreneurship**	1	2
	Skill Enhancement Course – SEC-3: **Animal Behaviour**	1	2
	Naan Mudhalvan Course-1: Language Proficiency for Employability- Overview of English Communication*- Cambridge (Handled by English)	2	2
	Total	**23**	**30**

Second Year Semester – III

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	6
Part-3	Core Course V: **Cell Biology** Core Course VI: **Lab on Cell Biology** Elective-III (Generic /Discipline Specific): **Chemistry for Biological Sciences-I** Elective-III Lab Course: **Volumetric Analysis**	4 2 3 2	4 2 4 2
Part-4	Skill Enhancement Course – SEC-4: **Economic Zoology / Medical Laboratory Techniques**	1	2
	Naan Mudhalvan Course-2 (Poultry Science and Management*) * *Substitute paper exclusively for reappearance only*	2	2
	E.V.S	2	2
	Total	**22**	**30**

Second Year Semester – IV

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	6
Part-3	Core Course VII: **Genetics and Evolution** Core Course VIII: **Lab on Genetics and Evolution** Elective-IV (Generic /Discipline Specific): **Chemistry for Biological Sciences - II** Elective-IV Lab Course: **Systematic Analysis of Organic Compounds.**	4 2 3 2	4 2 4 2
Part-4	Skill Enhancement Course – SEC-5: **Basics of Marine Biology /** **Wildlife Conservation and Management**	1	2
	Naan Mudhalvan Course-3 (Basic Course in Ornithology*) * *Substitute paper exclusively for reappearance only*	2	2
	Value Education	2	2
	Total	**22**	**30**

Third Year Semester – V

Part	List of Courses	Credit	No. of Hours per week
Part-3	Core Course IX: **Animal Physiology and Biochemistry**	4	5
	Core Course X: **Environmental Biology**	4	5
	Core Course XI: **Lab on Animal Physiology and Biochemistry & Environmental Biology**	3	4
	Core Course XII: **PROJECT / Food, Nutrition and Health**	5	4
	Elective-V (Generic /Discipline Specific): **Biostatistics and Computer Application**	3	4
	Elective-VI (Generic /Discipline Specific): **Agricultural Entomology / Sericulture / Vermitechnology**	3	4
	Elective Lab – V: **Lab on Biostatistics and Computer Application, & Elective -VI**	2	2
Part-4	Internship / Industrial Visit / Field Visit / Knowledge updation activity	2	0
	Naan Mudhalvan Course-4 (Basics of Marine Biology*) * *Substitute paper exclusively for reappearance only.*	2	2
	Total	**28**	**30**

Third Year Semester – VI

Part	List of Courses	Credit	No. of Hours per week
Part-3	Core Course XIII: **Developmental Biology**	4	6
	Core Course XIV: **Microbiology and Immunology**	4	6
	Core Course XI: **Lab on Developmental Biology & Microbiology and Immunology**	3	4
	Elective-VII (Generic /Discipline Specific): **Animal Biotechnology and Bioinformatics**	3	5
	Elective-VIII (Generic /Discipline Specific): **Applied Zoology / Apiculture / Aquaculture**	3	5
	Elective Lab – VI: **Lab on Animal Biotechnology and Bioinformatics, & Elective -VIII**	2	2
Part-4	**Naan Mudhalvan Course-5** (Aquarium Keeping*) * *Substitute paper exclusively for reappearance only.*	2	2
Part-5	Extension Activity (NSS / NCC / YRC / RRC / Sports / Youth Welfare activities)	1	-
	Total	**22**	**30**

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B.Sc Zoology

First Year
Semester – I

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	6
Part-3	**1.** Core Course I: **Invertebrata** 2. Core Course II: **Lab on Invertebrata** 3. Elective-I (Generic /Discipline Specific): **Allied Botany I /** **Industrial Fish and Fisheries-I Biology of fish** 4. Lab Course: **Elective-I- Lab on Allied Botany /** **Industrial Fish Fisheries-I Biology of Fish**	5 3 3 2	5 3 4 2
Part-4	Skill Enhancement Course – SEC-I: **Ornamental Fish Farming and Management**	2	2
	Foundation Course: **Introduction to Zoology**	2	2
	Total	**23**	**30**

SEMESTER – I
CORE COURSE 1.1 INVERTEBRATA

Course Code **CC1**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	INVERTEBRATA	Core	Y	-	-	-	5	5	25	75	100
CO1	To understand the basic concepts of lower animals and observe the structure and functions.										
CO2	To illustrate and examine the systematic and functional morphology of various groups of invertebrates.										
CO3	To differentiate and classify the various groups of animal modes of life and to estimate the biodiversity										
CO4	To compare and distinguish the general and specific characteristics of reproduction in lower animals.										
CO5	To infer and integrate the parasite and economic importance of invertebrate animals.										

UNIT	Details	No. of Hours	Course Objectives
I	**Protozoa**: Introduction to Classification, taxonomy and nomenclature. General characters and classification of Phylum Protozoa up to classes. Type study: *Paramecium* and	12	CO1, CO3, CO4

	Plasmodium - Parasitic protozoans (*Entamoeba*, *Trypanosoma* & *Leishmania*) - Economic importance Nutrition in protozoa - Host-parasitic interactions in *Entamoeba* and *Plasmodium* - Locomotion in protozoa **Porifera**: General characters and classification up to Classes. Type study: Sycon- Canal system in sponges. Reproduction in sponges		
II	**Coelenterata:** General characters and classification up to classes – Type study: *Obelia* - Corals and coral reefs - Economic importance of corals and coral reefs - Polymorphism in Hydrozoa. **Platyhelminthes:** General characters and classification of up to classes. Type study: *Fasciola hepatica*. Parasitic adaptations. Host-parasitic interactions of Helminthine parasites	12	CO2
III	**Aschelminthes** : General characters and classification of up to classes - Type study: *Ascaris lumbricoides.* Nematode Parasites and diseases - *Wuchereria bancrofti*, *Enterobius vermicularis*, *Ancylostoma duodenale*. - Parasitic adaptations. **Annelida:** General characters and classification up to Classes. Type study: *Nereis,* - Metamerism - Modes of life in Annelids.	12	CO3, CO4, CO5
IV	**Arthropoda:** General characters and classification of Phylum Arthropoda up to Classes. Detailed study: *Penaeus indicus*. Affinities of *Peripatus* – Larval forms in Crustacea. Economic importance of Insects. Insect pests of Agricultural Importance- - Pest of rice: Rice stem borer (*Scirpophaga incertulas*) – Pest of Sugarcane: The shoot borer (*Chilo infuscatellus*) – Pest of coconut: The rhinoceros beetle (*Oryctes rhinoceros*). Principles of Integrated Pest Management.	12	CO3, CO4, CO5
V	**Mollusca:** General characters and classification of Phylum Mollusca up to Classes. Detailed study: *Pila globosa*. Foot and torsion in Mollusca. Economic importance of Cephalopods. **Echinodermata:** General characters and classification of Phylum Echinodermata up to Classes. Detailed study: *Asterias.* Water vascular system in Echinodermata – Larval forms of Echinoderms.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes		
CO1	Understand the basic concepts of invertebrate animals and recall its structure and functions.	PO1
CO2	Illustrate and examine the systemic and functional morphology of various groups of invertebrata.	PO1, PO2
CO3	Differentiate and classify the animal's mode of life in various taxa and estimate the biodiversity.	PO4, PO6
CO4	To compare and distinguish the various physiological processes and organ systems in lower animals.	PO4, PO5, PO6
CO5	Infer and integrate the parasitic and economic importance of	PO3, PO8

	invertebrate animals.	
Text Books (Latest Editions)		
1	Ekambaranatha Iyer, 2000. *A Manual of Zoology*, 10th edition, Viswanathan, S., Printers & Publishers Pvt Ltd	
2	Jordan, E.L. and Verma P.S, 1995. *Invertebrate Zoology*, 12th edn. S. Chand& Co.	
3	Kotpal, R.L, 1992. *Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata.*	
Reference Books (Latest editions, and the style as given below must be strictly adhered to)		
1	Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.	
2	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science	
3	Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*, II Edition, E.L.B.S. and Nelson	
4	Hyman L.H, 1955. The invertebrates - Vol. I to Vol. VII – Mc Graw Hill Book Co.	
5	Parker, J. and Haswell , 1978. *A text book of Zoology Vol. I* - Williams and Williams.	
Web Resources		
1	https://www.nationalgeographic.com/animals/invertebrates/	
2	https://www.britannica.com/science/parasitic-disease	
3	https://www.nio.res.in/	
4	https://greatbarrierreef.org/	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – I
LAB ON CORE COURSE I - INVERTEBRATA

Course Code **CC2**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB ON INVERTEBRATA	Core	Y	-	-	-	3	3	50	50	100

Learning Objectives	
CO1	To dissect and mount various body parts and to study the various functional details of invertebrates
CO2	To understand the organs, organ system and their functions in lower animals.
CO3	To dissect and mount various body parts and to study the various functional details of chordates
CO4	To identify the different groups of invertebrate animals by observing their external characteristics.
CO5	To identify the different groups of Invertebrates to gather adequate knowledge and to record.

UNIT	**Details**		**Course Objectives**
I	**Dissection**: 1. Cockroach: Nervous system 2. Cockroach: Reproductive system		CO1
II	**Dissection:** **3.** Cockroach: Digestive system		CO2
III	**Mounting:** 1. Mouth Parts – Cockroach 2. Mouth Parts - Honey bee, Mosquito, House fly 3. Prawn appendages 4. Earth worm – body setae, penial setae (Demo)		CO3
IV	**Spotters: (i). Protozoa:** Amoeba, Paramoecium, Paramoecium Binary fission and Conjugation, Entamoeba histolytica, Plasmodium vivax **(ii). Porifera:** Sycon, Gemmule **(iii). Coelenterata:** Obelia – Colony & Medusa, Aurelia, Physalia,		CO4

	Gorgonia, **(iv). Platyhelminthes:** Planaria, Fasciola hepatica, Fasciola larval forms – Miracidium, Redia, Cercaria, Taenia solium, **(v). Nemathelminthes:** Ascaris (Male & Female), **vi). Annelida:** Nereis, Chaetopteurs, Hirudinaria, Trochophore larva **(vii). Arthropoda:** Cancer, Palaemon, Scorpion, Scolopendra, Sacculina, Limulus, Peripatus, Larvae - Nauplius, Mysis, Zoea,. **(viii). Mollusca:** Chiton, Pila, Unio, Pteredo, Murex, Sepia, Loligo, Octopus, **(ix). Echinodermata:** Asterias, Ophiothrix, Cucumaria, Antedon, Bipinnaria larva		
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO5

Course Outcomes		
CO1	Identify and label the external features of different groups of invertebrate animals.	PO1
CO2	Illustrate and examine the nervous system and reproductive system of invertebrate animals.	PO1, PO2
CO3	Differentiate and compare the structure, function and mode of life of various groups of animals.	PO4, PO6
CO4	Compare and distinguish the dissected internal organs of lower animals.	PO4, PO5, PO6
CO5	Prepare and develop the mounting procedure of economically important invertebrates.	PO3, PO8

Text Books (Latest Editions)	
1	Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 *A manual of Zoology Vol.I* (Part 1, 2) S. Viswanathan, Chennai
2	Ganguly, Sinha an d Adhikari , 2011 . *Biology of Animals: Volume I,* New Central Book Agency; 3rd revised edition. 1008 pp.
3	Sinha, Chatterjee and Chattopadhyay, 2014. *Advanced Practical Zoology*, Books & Allied Ltd; 3rd Revised edition, 1 07 0 pp.
4	Lal ,S. S, 2016 . *Practical Zoology Invertebrate*, Rastogi Publications.
5	Verma, P. S. 2010. A Manual of Practical Zoology: Invertebates, S Chand, New Delhi

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

Web Resources	
1	https://nbb.gov.in/
2	https://www.agshoney.com/training.htm

3	https://icar.org.in/
4	https://nisa.icar.gov.in/
5	https://www.nationalgeographic.com/animals/invertebrates/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – I PART – IV

Skill Enhancement Course – SEC-1

ORNAMENTAL FISH FARMING AND MANAGEMNT

Hours: 2 Credit- 2

COURSE OUTCOMES

Students will able to

(i) Highlight the importance of ornamental fish culture in entrepreneurship development.
(ii) Know the identification, culture and maintenance of commercially important ornamental fishes.
(iii)Acquire knowledge of the techniques of ornamental fish breeding, rearing, disease control and economics of ornamental fish farming.

Unit I:

Introduction to ornamental fish keeping: Scope and importance of ornamental fish culture. Identification of commercially important ornamental fishes - Indigenous and exotic varieties.

Unit II:

Biology of egg layers and live bearers: Breeding, hatchery and nursery management of egg layers (eg. Goldfish) and live bearers (eg.Guppy).

Unit III:
Aquarium plants and their propagation: Food and feeding in ornamental fishes. Formulated feed and Live feed; Live feed culture. Identification of locally available live feed organisms.
Unit IV:
Aquarium design and construction: Accessories - aerators, filters and lighting Maintenance of aquarium and water quality management. Ornamental fish diseases, their prevention, control and treatment methods.
Unit V:
Conditioning, packing, transport and quarantine methods. Economics, trade regulations, domestic and global export potential and marketing strategies.

References:

1. Swain SK., Sarangi N. and Ayyappan S. (2010). *Ornamental fish farming*. ICAR, New Delhi.
2. *Living Jewels – A handbook on freshwater ornamental fish*, (1999) MPEDA, Kochi.
3. Dey V.K.A. (1997). *A handbook on aquafarming ornamental fishes*. MPEDA, Kochi.
4. Ahilan, B., Felix N. and Santhanam R. (2008), *Text book of aquariculture*. Daya Publishing House, New Delhi.

Web Resources

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

SEMESTER – I PART – IV

Foundation course

INTRODUCTION OF ZOOLOGY

Hours: 2 Credit- 2

LEARNING OBJECTIVES

1. To Know the different types of animals in the animal kingdom.
2. To gain knowledge of the various branches of biology.
3. To attain knowledge on the livestock development in India and its future prospects

UNIT 1:
Animal Biodiversity and Systematics: Taxonomic hierarchy: Classification of animal kingdom- Two kingdoms and Five kingdom classification- Binomial nomenclature- Different phyla of animal kingdom – Salient features of Invertebrates and Chordates with examples.
UNIT 2:
Cell Biology & Genetics: Cell theory- Ultrastructure of a typical Prokaryotic and Eukaryotic cell- importance of cell organelles. General Account on Mendelism and inheritance- DNA and RNA- Central dogma of Molecular Biology.
UNIT 3:
Biochemistry and Physiology: Introduction to the role of essential biological Compounds- Proteins, Carbohydrates, Lipids, Water and Vitamins. Introduction to organ system of vital physiological functions.

UNIT 4:

Environmental Biology: Basics of atmosphere and its strata- habitats- concept and components of ecosystem. **Developmental Biology:** General account of gametogenesis-fertilization and developmental stages. **Evolution:** Origin of life - Darwinism- Modern synthetic theory.

UNIT 5:

Entrepreneurial Courses in Zoology: General introduction and applications: Aquaculture - Aquarium keeping - Apiculture - Sericulture - Lac culture - Vermiculture - Poultry keeping- Dairy farming- Biotechnology-Ecotourism.

References:

1. Ekambaranatha Iyer, (2000), *A Manual of Zoology*, 10th edition, Viswanathan, S., Printers & Publishers Pvt Ltd
2. Jordan, E.L. and Verma P.S, (1995), *Invertebrate Zoology*, 12th edn. S. Chand& Co.
3. Kotpal, R.L.(2019), *Modern text book of Zoology: Invertebrates*. Rastogi Publication, New Delhi.
4. Kotpal (2015). *Modern Textbook of Zoology Vertebrates*, Rastogi publishers, New Delhi.
5. H.C, Nigam. (2010), *Biology of Chordates*., Vishal Publications, New Delhi
6. Gupta. P.K., (2017), *Cell and Molecular Biology,* Fifth Revised Edition, Rastogi Publication, Meerut, India.
7. Singh. H.R, & Neeraj Kumar (2017), *Animal Physiology and Biochemistry*, Vishal Publishing Co.
8. Erach Bharucha. (2005). *Text book of Environmental Studies for undergraduate courses*, University Grants Commission, New Delhi.
9. Shukla, G.S. & Upadhyay, V.B. (2014). *Applied and Economic Zoology*, Rastogi Publications.
10. Cherian M.C. & Ramachandran, (1952), *Bee keeping in South India* – Govt.Press,Chennai.
11. Johnson and Jeyachandra, (2000), *Apiculture* –, Marthandam, TamilNadu.
12. Kesary, M and M.Johnson, (1998), *Sericulture*, Department of Zoology, N.M.. Christian College, Marthandam.
13. Ganga. G, (2019), *Introduction to Sericulture*, Oxford and IBH Publishing
14. Jhingaran, V.G., (1997), *Fish and Fisheries of India*, Hindustan Publishing Corporation (India).
15. *Poultry farm manual: A reference guide for Central and State Poultry Farms*, (2014),- www.dadf.gov.in and www.dadh.nic.inDelhi.
16. Gnanamani M.R, (2010), Modern aspects of commercial poultry keeping, Deepam Publications, Madurai.
17. Santhanakumar, G &A.M. Selvaraj. (1993), *Concepts of Aquaculture*. Meenam Publications. Nagercoil Lekshmi Papers, Thirumal Complex, Opp. Chakkaravarthi theatre. Chettikulam Jn., Nagercoil – 629 002.
18. Sundararaj, V. &B. Srikrishnadhas, *Cultivable Aquatic Organisms*, Narendra Publishing House,1417, Kishan Dutt street, Maliwara, Delhi – 110 006
19. Singh, Herbans and Earl Moore, (1968), *Livestock and Poultry Production*, Prentice Hallin India.
20. Seethaleksmy, M and Dr.Samthi, R, (2012),.*Vermitechnology*, Saras Publications , Nagercoil.

Web references:

1. http//lib.mylibrary.com/ Open.aspx?id=463009
2. http://globalacademicgroup.com...pdf
3. http://tbmicollege.ac.in>gallery
4. http://www.researchgate.net>3473
5. http://www.periyaruniversity.ac.in
6. http://www.profitableventure.com>
7. http://www.thinkwithniche.cpm>five
8. http://www.99businessideas.com

B.Sc Zoology

First Year Semester – II

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	4
Part-3	**1.** Core Course III: **Chordata** **2.** Core Course IV: **Lab on Chordata** 3. Elective-II (Generic /Discipline Specific): **Allied Botany II /** **Industrial Fish and Fisheries-II Biology of fish** 4. Lab Course: Elective-II- **Lab on Allied Botany II /** **Lab on Industrial Fish Fisheries-II Biology of Fish**	5 3 3 2	5 3 4 2
Part-4	Skill Enhancement Course – SEC-2: **Bio Composting for Entrepreneurship**	1	2
	Skill Enhancement Course – SEC-3: **Animal Behaviour**	1	2
	Naan Mudhalvan Course-1: Language Proficiency for Employability- Overview of English Communication*- Cambridge (Handled by English)	2	2
	Total	**23**	**30**

SEMESTER – II
CORE COURSE 2.1 CHORDATA

Course Code **CC3**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	CHORDATA	Core	Y	-	-	-	5	5	25	75	100
CO1	To understand the structures and distinct features of Phylum Chordata.										
CO2	To understand and able to distinguish the characteristic features of each subphylum and class.										
CO3	To understand the economic importance of vertebrates.										
CO4	To know about the adaptations of vertebrates.										
CO5	To understand the evolutionary position of different groups of vertebrates.										

UNIT	Details	No. of Hours	Course Objectives
I	**General Characters and Classification of Phylum Chordata**: Origin of Chordata, Differences between non-chordates and chordates, General characters of chordates and prochordates, Affinities and Systematic position of Hemichordata	12	CO1, CO2

	(*Balanoglossus*), Urochordata (*Ascidia*), Cephalochordata (*Amphioxus*).		
II	**Characteristics of subphylum Vertebrata**, Classification of Vertebrata upto Class level, Agnatha - *Petromyzon* - Ammocoetus larva. Pisces - Type study : *Scoliodon sorrakowah*. General characters and classification of Pisces, Origin of fishes, Affinities of Dipnoi - Types of scales and fins - Accessory respiratory organs - Parental care - Migration - Economic importance.	12	CO1, CO2, CO4, CO5
III	**Amphibia:** General characters and classification - Origin of Amphibia - Type study : *Rana hexadactyla* - Adaptive features of Anura, Urodela and Apoda - Neoteny in Urodela - Parental care in Amphibia.	12	CO1, CO2, CO3, CO4, CO5
IV	**Reptilia:** General characters and classification - Type study: *Calotes versicolor* - Origin of reptiles, Extinct reptiles. Snakes of India – Identification of Poisonous and non-poisonous snakes - Poison apparatus and biting mechanism of poisonous snakes and first aid. Skull in reptiles as basis of classification	12	CO1, CO2, CO4, CO5
V	**Aves and Mammalia:** Aves: General characters and classification – Type study: *Columba livia* - Origin of birds, Flight adaptations, Migration. Mammalia: General characters and classification - Type study: *Rabbit* - Adaptive radiation in mammals - Egg laying mammals, Marsupials, Flying mammals, Aquatic mammals, Dentition in mammals.	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes		
CO1	Classify, identify and recall the name and distinct features of different subphylum belonging to phylum Chordata.	PO1
CO2	Explain, and relate the origin, structural organization and evolutionary aspects of vertebrates.	PO1, PO2
CO3	Analyze, compare and distinguish the developmental stages and describe the important biological process.	PO3, PO4, PO6
CO4	Correlate the different modes of life and parental care among different vertebrates.	PO3, PO5, PO6
CO5	Summarise the morphology and ecological adaptations in vertebrates and list out the economic importance.	PO2, PO3, PO5, PO8

Text Books (Latest Editions)	
1	Ayyar, E.K. and T.N. Ananthakrishnan, (1992), *Manual of Zoology Vol. II* (Chordata), S. Viswanathan (Printers and Publishers) Pvt Ltd., Madras.
2	Jordan, E.K. and P.S. Verma, (1995), *Chordate Zoology and Elements of Animal Physiology*, 10th edition, S. Chand & Co Ltd., Ram Nagar, New Delhi,
3	Nigam, H.C., (1983), *Zoology of Chordates,* Vishal Publications, Jalandhar - 144008,
4	Ganguly, Sinha,. Bharati Goswami and Adhikari, (2004), *Biology of animals Vol.II* - New central book Agency (p) Ltd.
5	Kotpal. R.L. A, (2009), *Modern text book of Zoology Vertebrates*- Rastogi

	publications.
Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Darlington P.J. (2017), *Zoogeography:The Geographical Distribution of Animals*, R.E. Krieger Pub. Co.
2	Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution. IV* Edition. Jones and Bartlett Publishers Inc.
3	Hickman, C.P. Jr., F.M.Hickman and L.S. Roberts, (1984), *Integrated Principles of Zoology,* 7th Edition, Times Merror/Mosby College Publication. St. Louis.
4	Newman, H.H., (1981), *The Phylum Chordata*, Satish Book Enterprise, Agra – 282 003
5	Parker and Haswell, (1964), *Text Book of Zoology, Vol II (Chordata)*, A.Z.T,B.S. Publishers and Distributors, New Delhi - 110 051
6	Pough H. (2009) *Vertebrate life*, VIII Edition, Pearson International.
7	Waterman, Allyn J. et al., (1971), *Chordate Structure and Function*, Mac Millan &Co., New York
8	Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
Web Resources	
1	http://tolweb.org/Chordata/2499
2	https://www.nhm.ac.uk/
3	https://bit.ly/3Av1Ejg
4	https://bit.ly/3kqTfYz
5	https://biologyeducare.com/aves/
6	https://www.vedantu.com/biology/mammalia

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – II
LAB ON CORE COURSE II - CHORDATA

Course Code **CC4**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB ON CHORDATA	Core	-	-	Y	-	3	3	50	50	100

Learning Objectives	
CO1	To understand the structures and distinct features of Phylum Chordata.
CO2	To understand and able to distinguish the characteristic features of each subphylum and class.
CO3	To understand and compare the structure of various internal organs in different classes of vertebrates.
CO4	To know about the classification, adaptations and affinities of chordate animals.

UNIT	**Details**		**Course Objectives**
I	**Dissections:** Fish: External features, Digestive system (Sardine or any other fish) Frog: External features, Digestive system (Demo), Arterial System (Demo/Virtual)		CO1
II	**Mounting:** Fish: Placoid and Ctenoid scales, Frog: Hyoid apparatus and Brain (Demonstration).		CO2
III	**Osteology:** Frog/ mammal: Skull and lower jaw, Vertebral column, Pectoral girdle, Pelvic girdle, Fore limb, Hind limb, Chelonia: Anapsid skull. Pigeon: skull, lower jaw and synsacrum.		CO3
IV	**Specimen and Slides:** 1. **Hemichordata:** Balanoglossus, Tornaria larva 2. **Protochordata:** Amphioxus, Amphioxus		CO4

	3. **Cyclostomata:** Petromyzon, Ammocoetus larva 4. **Pisces:** Shark, Pristis, Torpedo, Anabus, Cybium, Hippocampus, Exocoetus, Echieneis, Labeo, Catla, Clarius, Anguilla, Protopterus, 5. **Amphibia:** Ichthyophis, Amblystoma, Hyla, Rachophous, Bufo, Rana, Axolotal larva 6. **Reptilia:** Draco, Chemaeleon, Vipera russelli, Naja, Bungarus, Enhydrina, Typhlops, Trionyx, Crocodilus, Chelon. 7. **Aves:** Archaeopteryx, Passer, Psittacula, Bubo, Alcedo, Columba, Corvus, Pavo, **Collection and study of different types of feathers:** Quill, Contour, Filoplume, Down 8. **Mammalia:** Ornithorhynchus, Pteropus, Manis, Loris, Hedgehog		
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO5

Course Outcomes		
CO1	Identify and label the external features of different groups of invertebrate animals.	PO1
CO2	Illustrate and examine the nervous system and reproductive system of invertebrate animals.	PO1, PO2
CO3	Differentiate and compare the structure, function and mode of life of various groups of animals.	PO4, PO6
CO4	Compare and distinguish the dissected internal organs of lower animals.	PO4, PO5, PO6
CO5	Prepare and develop the mounting procedure of economically important invertebrates.	PO3, PO8

Text Books (Latest Editions)	
1	Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 *A manual of Zoology Vol.I* (Part 1, 2) S. Viswanathan, Chennai
2	Ganguly, Sinha an d Adhikari , 2011 . *Biology of Animals: Volume I,* New Central Book Agency; 3rd revised edition. 1008 pp.
3	Sinha, Chatterjee and Chattopadhyay, 2014. *Advanced Practical Zoology*, Books & Allied Ltd; 3rd Revised edition, 1 07 0 pp.
4	Lal ,S. S, 2016 . *Practical Zoology Invertebrate*, Rastogi Publications.
5	Verma, P. S. 2010. A Manual of Practical Zoology: Invertebates, S Chand, New Delhi

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
2	Barnes, R.D. (1982). *Invertebrate Zoology,* V Edition. Holt Saunders International Edition.
3	Barrington, E.J.W. (1979). *Invertebrate Structure and Functions. II Edition,* E.L.B.S. and Nelson
4	Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.

5	Lal, S.S. (2005), *A text Book of Practical Zoology*: Invertebrate, Rastogi, Meerut
Web Resources	
1	https://www.youtube.com/watch?v=b04hc_kOY10
2	https://bit.ly/3CzTEy8
3	http://tolweb.org/Chordata/2499
4	https://www.nhm.ac.uk/
5	https://bit.ly/3Av1Ejg

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER - II

PART – IV

Skill Enhancement Course – SEC-2

BIOCOMPOSTING FOR ENTREPRENEURSHIP

Hours: 2 Credit- 1

Learning Objectives:

- To highlight the importance of Biocomposting for entrepreneurship in waste management.
- To enable students to set up Biocompost units and bins for waste reduction.

Course outcomes:

- The students will gain knowledge about the process of Biocomposting.
- Students will be able to demonstrate Biocomposting techniques for various end applications like solid waste management, industrial waste recycling using sugarcane bagasse, etc.
- To learn about the economic cost of establishing small Biocompost units as a cottage industry.

Unit – I

Biocomposting – Definition, types and ecological importance.

Unit – II

Types of Biocomposting technology – Field pits/ground heaps/ tank/large-scale/batch and continuous methods.

Unit – III

Preparation of Biocompost pit and bed using different amendments.

Unit – IV

Applications of Biocompost in soil fertility maintenance, promotion of plant growth, value added products, waste reduction, etc.

Unit – V

Economics of establishment of a small biocompost unit – project report proposal for Self Help Group (Income and employment generation).

Practical

- Preparation procedures for Biocompost pit.
- Selection of Biocompost material, separation of Compostable and Non-compostable materials.
- Packing and marketing of Biocompost.
- Field visit to Biocomposting unit.

References

1. Bikas R. Pati& Santi M. Mandal (2016). Recent trends in composting technology.

2. Van der Wurff, A.W.G., Fuchs, J.G., Raviv, M., Termorshuizen, A.J. (Editors) 2016. Handbook for Composting and Compost Use in Organic Horticulture. BioGreenhouse COST Action FA 1105, www.biogreenhouse.org.

SEMESTER - II

PART – IV

Skill Enhancement Course – SEC-3

ANIMAL BEHAVIOUR

Hours: 2 Credit- 1

Learning Objectives:

1. To learn the origin and development of animal behaviour and to understand the influence of genetics, environment on animal behaviours.
2. To understand the biological properties of animal behavior, with an evolutionary and ecological emphasis.
3. To Compare innate and learned behavior and differentiate between various mating system.
4. To impart the knowledge about visual and auditory communication; courtship, mate choice, and mating systems; social behavior and social systems; and animal personality.
5. To discuss how movement and migration behaviors are a result of natural selection.

Unit I:

Genetics and Behaviour: Genetic material, Genes and chromosomes, Genetic variation, Single and Polygenic inheritance of behaviour, Heritability of behaviour, Natural selection and behaviour, Frequency distribution of phenotypes, Darwinian fitness, Evolution of adaptive strategies.

Unit II:

Evolution and Social Behaviour: Sexual selection, Altruism, and social organisation, Animal perception, Neural control of behaviour, Visual adaptations to unfavourable environments.

Unit III:

Animal and the Environment: Coordination and Orientation, Homeostasis and Behaviour, Physiology and Behaviour in changing environments, Animal Learning, Conditioning and Learning, Cognitive aspects of learning.

Unit IV:

Understanding Complex Behaviour: Instinct and learning, Displacement activities, Decision making behaviour in Animals, Complex behaviour of hobby bees, Mechanism of Decision making. The mentality of Animals: Languages and mental representation, non-verbal communication in humans, mental images, Intelligence, tool use and culture.

Unit V:

Chronobiology : Organization of circadian system in multicellular animals; Concept of central and peripheral clock system; Photoreception and photo- transduction; Thephysiological clock and measurement of day length; The relevance of biological clocks for human welfare - Clock function (dysfunction).

Text Books

1. David McFarland, (1985), *Animal Behaviour*, Longman Scientific & Technical, UK.
2. Harjindra Singh,(1990), *A Text Book of Animal Behaviour,* Anomol Publication.
3. Hoshang S.Gundevia and Hare Goving Singh, (1996), *Animal Behaviour,* S.Chand & Co.

4. Shukla, J. P (2010), *Fundamentals of Animal Behaviour*, Atlantic.
5. Vinod Kumar, (2002), *Biological Rhythms.* Narosa Publishing House, Delhi.

Suggested Readings

1. Michael D. Breed and Janice Moore, (2012), *Animal Behaviour*, Academic Press, USA.
2. Aubrey Manning and Martin Stamp Dawkins, (2012), *An Introduction to Animal Behaviour*, 6th Edition, Cambridge University Press, UK.
3. Davis E.Davis, (1970), *Integral Animal Behaviour,* Mac Millan Company, London,
4. Jay, C. Dunlap, Jennifer, J. Loros, Patricia J. De Coursey (ed). (2004), *Chronobiology Biological time Keeping,* Sinauer Associates Inc, Publishers, Sunderland, MA.

Web Resources

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

Course Outcomes (COs)

1. Recall and record the genetic basis and evolutionary history of behaviour.
2. Classify movement and migration behaviors and explain environmental influence upon behaviour.
3. Analyze and identify innate, learned and cognitive behavior and differentiate between various mating systems.
4. Assess complexity involved in behavioural traits and evaluate hormones and their role in aggression and reproduction.
5. Discuss the rhythmicity of behavioural expressions and the scientific concepts in behavior and behavioral ecology.

B.Sc Zoology
Second Year
Semester – III

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	6
Part-3	1. Core Course V: **Cell Biology** **2.** Core Course VI: **Lab on Cell Biology** 3. Elective-III (Generic /Discipline Specific): **Chemistry for Biological Sciences-I** 4. Elective-III Lab Course: **Volumetric Analysis**	4 2 3 2	4 2 4 2
Part-4	Skill Enhancement Course – SEC-4: **Economic Zoology / Medical Laboratory Techniques**	1	2
	Naan Mudhalvan Course-2 (Poultry Science and Management*) * *Substitute paper exclusively for reappearance only*	2	2
	E.V.S	2	2
	Total	**22**	**30**

SEMESTER – III
CORE COURSE- V: CELL BIOLOGY

Course Code **CC5**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	CELL BIOLOGY	Core	Y	-	-	-	4	4	25	75	100
CO1	To understand the various techniques used to study the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes and organelles.										
CO2	To understand how these cellular components are used to generate and utilize energy in cells.										
CO3	To understand the cellular components.										
CO4	To apply the knowledge of cell biology and its significance to cell function.										
CO5	To understand different types of cell division.										

UNIT	Details	No. of Hours	Course Objectives
I	**History of Cell Biology and Cell theory,** Tools and Techniques of Cell Biology, Cell Fractionation, Homogenization, Centrifugation, Staining - Vital Stains. – Cytoplasmic and Nuclear Stains. Micro Technique Methods, Microscopes - Types - Light,	12	CO1, CO2

	Compound, Phase contrast, SEM, TEM - Units of measurement.		
II	**The Cell** - Ultra structure of Plant & Animal cell - Cytoplasm - Structure and Composition, Function - Cytoplasmic Inclusions. Viruses & Bacteria -Types and Structure	12	CO1, CO2, CO4, CO5
III	**Cell components** - Plasma Membrane: Ultra Structure - Different Models – Functions, Ultrastructure and functions: Endoplasmic reticulum, Ribosomes, Golgi Complex, Lysosomes, Centrioles, Microtubules, and Mitochondria.	12	CO1, CO2, CO3, CO4, CO5
IV	**Nucleus** - Ultrastructure, Composition and Functions, Nuclear Membrane - Nucleoplasm - Chromosomes - Heterochromatin and Euchromatin – Giant chromosomes, Nucleolus, DNA- structure and types, DNA replication and types of replication - RNAs - Protein Synthesis & regulation.	12	CO1, CO2, CO4, CO5
V	**Cell Divisions and Cell Cycle** - Amitosis, Mitosis and Meiosis and their Significance - **Cancer Biology** – Characteristics of cancer cells, types, theories on Carcinogenesis, Ageing of Cells – Apoptosis	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes		
CO1	Integrate and assess the biochemical, cytological and histological tools to infer cellular basis of organization. Understand and recall the basic structure, origin and development of cell organelles.	PO1
CO2	Understand and recall the basic structure, origin and development of cell organelles.	PO1, PO3
CO3	Analyse and differentiate cellular components based on structure, composition and inter and intra cellular interactions.	PO3, PO4, PO5
CO4	Explain the role of cells and cell organelles in various biological processes.	PO1, PO3, PO5, PO6, PO8
CO5	Understand the structure and complexity of cells and cell organelles.	PO3, PO4, PO5, PO6, PO7, PO8

Text Books (Latest Editions)	
1	Ambrose, E.J. and Dorothy, M. Easty, 1970. Cell Biology, Thomas Nelson & Sons Ltd.,
2	Kumar P. and Mina U. (2018) Life Sciences: Fundamentals and Practice, Part-I, 6th Edn., Pathfinder Publication.
3	VeerBala Rastogi, Introductory cytology. Kedar Nath Ram Nath. Meerut 250 001.
4	Verma, P.S. and V. K.Agarwal, 1995. Cell and Molecular Biology, 8th Edition, S.Chand & co., New Delhi - 110 055.
5	Verma P.S. and Agarwal V.K. (2016) Cell Biology (Cytology, Biomolecules, Molecular Biology), Paperback, S. Chand and Company Ltd.

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Albert B., Hopkin K., Johnson A.D., Morgan D., Raff M., Roberts K. and Walter P. (2018), *Essential Cell Biology* ,5th Edn.,(paperback) W.W. Norton & Company p.864.

2	Burke, Jack. D., 1970. Cell Biology, Scientific Book Agency, Calcutta.
3	Challoner J. (2015), *The Cell: A visual tour of the building block of life*, The University of Chicago Press and Ivy Press Ltd., p.193.
4	Cohn, N. S., (1979), *Elements of Cytology*, Freeman Book Co., New Delhi – 110007, 495 pp
5	Cooper G.M. (2019) *The Cell – A Molecular Approach*, 8th Edn., Sinauer Associates Inc., Oxford University Press p.813.
6	DeRobertis, E.D.P. and E.M.F. De Robertis, (1988), *Cell and Molecular Biology*, 8th Edition, International Edition, Info med, Hong Kong, 734pp.
7	Dowben, R., (1971), *Cell Biology*, Harper International Edition. Harper and Row Publisher, New York, 565 pp.
8	Giese, A.C., (1979), *Cell Physiology*, Saunders Co., Philadelphia, London, Toronto, 609 pp.
9	Hardin J. and Bertoni G. (2017), *Becker's World of the Cell*. 9th Edn (Global Edition). Pearson Education Ltd., p. 923
10	Karp G., Iwasa J. and Masall W. (2015), *Karp's Cell and Molecular Biology Concepts and Experiments*. 8th Edn. John Wiley and Sons. p.832.
11	Loewy, A.G. and P.Sickevitz, (1969), *Cell Structure and Function*, Amerind Publishing Co., NewDeihi - 110 020, 516 pp.
12	Mason K.A., Losos J.B. and Singer S.R. (2011), *Raven and Johnson's Biology*. 9th Edn. Mc Graw Hill publications. p.1406.
13	Powar, C.B., (1989), *Essential of Cytology*, Himalaya Publishing House, Bombay - 400 004, 368 pp.
14	Swansen, C.P. and P.L.Webster, (1989), *The Cell*, Prentice Hall of India Pvt. Ltd., New Delhi - 110 001, 373 pp.
15	Urry L.A. Cain M.L., Wasserman S.A., Minorsky P.V., Jackson R.B. and Reece J.B. (2014), *Campbell Biology in Focus*, Pearson Education. p.1080.

Web Resources	
1	http://www.microscopemaster.com/organelles.html
2	https://bit.ly/3tXwDSB
3	https://bit.ly/3tWNpRX
4	https://bit.ly/3AuYR9M
5	https://rsscience.com/cell-organelles-and-their-functions/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems,

	Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2		M		S	S			S
CO3			S	S	S	S		S
CO4			S			M		
CO5			M	S	S	S		S

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

SEMESTER – III
CORE COURSE VI:
LAB ON CELL BIOLOGY

Course Code **CC6**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB ON CELL BIOLOGY	Core	-	-	Y	-	2	2	50	50	100

Learning Objectives	
CO1	To encourage students to learn to focus the microscope and usage of ocular & stage micrometer, camera lucida.
CO2	To impart the skills required to understand the nature and types of blood cells and to understand various histochemical and micro techniques and to prepare and observe the chromosome arrangement during cell division.
CO3	To dissect and mount various body parts and to study the various functional details of chordates
CO4	To identify the different groups of invertebrate animals by observing their external characteristics.
CO5	To identify cell and organelles structure and to record.

UNIT	**Details**		**Course Objectives**
I	**Micrometry**- use of microscopes – microscopes - light microscope, camera lucida, stage and ocular micrometer.		CO1
II	Preparation and Identification of Mitotic divisions with Onion Root Tip Cells.		CO2

	Preparation and Identification of different stages of Meiosis in Grasshopper testis - Demonstration only. Staining and observation of polytene chromosome in salivary glands of Chironomous larva.		
III	Mounting of buccal epithelium and using vital stains. Preparation of human blood smear Preparation of frog blood smear		CO3
IV	**Spotters:** Plant cell, Animal cell, T_4 bacteriophage, *E.coli*, Ribosomes, Mitochondria, Golgi Apparatus, Endoplasmic Reticulum, Giant Chromosome, Nucleus, DNA, t-RNA,		CO4
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO5
Course Outcomes			
CO1	Identify and label the external features of different groups of invertebrate animals.	PO1	
CO2	Illustrate and examine the nervous system and reproductive system of invertebrate animals.	PO1, PO2	
CO3	Differentiate and compare the structure, function and mode of life of various groups of animals.	PO4, PO6	
CO4	Compare and distinguish the dissected internal organs of lower animals.	PO4, PO5, PO6	
CO5	Prepare and develop the mounting procedure of economically important invertebrates.	PO3, PO8	
Text Books (Latest Editions)			
1	Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 *A manual of Zoology Vol.I* (Part 1, 2) S. Viswanathan, Chennai		
2	Ganguly, Sinha an d Adhikari , 2011 . *Biology of Animals: Volume I,* New Central Book Agency; 3rd revised edition. 1008 pp.		
3	Sinha, Chatterjee and Chattopadhyay, 2014. *Advanced Practical Zoology*, Books & Allied Ltd; 3rd Revised edition, 1 07 0 pp.		
4	Lal ,S. S, 2016 . *Practical Zoology Invertebrate*, Rastogi Publications.		
5	Verma, P. S. 2010. A Manual of Practical Zoology: Invertebates, S Chand, New Delhi		
Reference Books (Latest editions, and the style as given below must be strictly adhered to)			
1	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science		
2	Barnes, R.D. (1982). *Invertebrate Zoology,* V Edition. Holt Saunders International Edition.		
3	Barrington, E.J.W. (1979). *Invertebrate Structure and Functions. II Edition,* E.L.B.S. and Nelson		
4	Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.		
5	Lal, S.S. 2005. *A text Book of Practical Zoology*: Invertebrate, Rastogi, Meerut		
Web Resources			
1	https://nbb.gov.in/		
2	https://www.agshoney.com/training.htm		

3	https://icar.org.in/
4	https://nisa.icar.gov.in/
5	https://www.nationalgeographic.com/animals/invertebrates/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

PART – IV

Skill Enhancement Course – SEC-4

4.1 ECONOMIC ZOOLOGY

Hours: 2 Credit- 1

Learning Objective

1. To understand different farm animals' culturing techniques and production methods.
2. To know the life history of animals and disease control methods used in farming.
3. To understand the concept of breeding, cross-breeding and the importance of high-yield varieties.
4. To know about the marketing strategies.

Unit I:Economic Entomology : Apiculture: Species of honey bees – Social organisation of honey bee – selection of bees and location for apiary – Newton's bee hive – products of bee keeping – enemies and diseases of honey bees. Sericulture: Species of silkworm – life history of mulberry silkworm – Rearing of silkworm – pests and diseases of silkworm.

Unit II: Vermiculture : Introduction: Types of earthworms – ecological classifications of earthworms – Physical, chemical and biological changes caused by earthworms in the soil – Natural enemies of earthworms. Vermicomposting: vermicomposting methods – factors

affecting vermicomposting –Vemiculture unit. Harvesting of vermicompost – vermicast – advantages of vermicompost – vermiwash and its applications.

Unit III: Aquaculture : Freshwater aquaculture: Carp culture – types of ponds – preparation – maintenance – harvesting and management. Integrated and composite culture. Prawn culture. Marine Aquaculture: Edible – pearl oyster culture.

Unit IV: Poultry Farming : Poultry industry in India – Poultry for sustainable food production and livelihood - Commercial poultry farming – Nutritive value of egg and meat- Broiler management (Definition; Housing and equipment; Brooding, feeding and health cover of broilers; Record keeping; Broiler integration) – Layer management (Brooder; Grower and layer management; Culling of layers).

Unit V: Dairy Farming : Dairy farming – advantages of dairying – classification of cattle breeds – Indigenous and exotic breeds – Selection of dairy cattle. Breeding – artificial insemination – Dairy cattle management – housing – water supply – Common contagious diseases. Milk - Composition of milk – milk spoilage – pasteurization – Role of milk and milk products in human nutrition.

Text Books

1. Sastry, N.S.R., C.K.Thomas and R.A.Singh, (2015), *Livestock Production Management*, 4thEd.Kalyani Publishers, New Delhi.
2. ICAR, (2013), *Handbook of Animal Husbandry*, 4th Ed., ICAR Publication, Pusa, New Delhi.
3. Awasthi, V.B., (2012), *Introduction to General and Applied Entomology*, third edition, Scientific publishers, India.
4. Vasanthraj David, B and Ramamurthy, VV., (2012), *Elements of Economic Entomology*, Seventh edition, Namrutha publications, Chennai.
5. Shukla & Upadhyay, (2014), *Economic Zoology*, 5th edn. Rastogi Publication, Meerut New Delhi.
6. Mary Violet Christy, A. (2014). *Vermitechnology*, MJP Publishers, Chennai.
7. Gupta, S.M., (2010), *Text book of fishery*, Ann Backer, Mumbai.
8. Shailendra Ghosh, (2009), *Fisheries and aquaculture management*, Adhyayan, New Delhi.
9. David, B and Ananthakrishnan, T. N., (2006), *General and Applied Entomology,* Second edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, India.
10. Jagadish Prasad, (2002), *Principles and practices of Dairy Farm Management*, 3rd Ed. Kalyani Publishers, Ludhiana.
11. Sukumar, D.E., (2002), *Outline of Dairy Technology*, Oxford University, New Delhi.
12. Rath, R.K., (2000), *Freshwater Aquaculture*. Scientific Publishers (India), Jodhpur.
13. Ismail, S.A., (1997), *Vermitechnology*, The biology of earthworms, Orient Longman, India.
14. Prabakaran, R. (1998), *Commercial Chicken Production*. Published by P. Saranya, Chennai.
15. Hafez, E. S. E., (1962), *Reproduction in Farm Animals*, Lea &Fabiger Publisher.

Suggested Readings

1. Glenn Munroe, (2017), *Manual of on-Farm Vermicomposting and Vermiculture*, Holdanca Farms Ltd, Wallace, Nova Scotia.
2. Hanifa, M.A., (2011), *Aquatic resources and aquaculture*, Dominent, New Delhi.
3. Gupta, P.K., (2008), *Vermicomposting for sustainable agriculture*, 2nd Edition, Agrobios, India.
4. Talashikar, S.C., (2008), *Earthworms in Agriculture*, Agrobios, India.
5. Abishek Shukla, D ., (2009), *A Hand Book of Economic Entomology*, Vedamse Books, New Delhi .
6. Banerjee, G.C., (2006), *Text book of Animal Husbandry*, 8thEd.Oxford and IBH Publishing Company Ltd., New Delhi.
7. Walstra, P. Wouters, J.T.M. and Geurts, T.J. (2006), *Dairy Science and Technology*. CRC Press, New York.
8. Dunham, R.A., (2004), *Aquaculture and Fisheries Biotechnology Genetic Approaches.* CABI publications, U.K.
9. Donald.D Bell and William. D. Weaver, (2002), *Commercial chicken meat and egg production*, Springer, New York.
10. Eckles C.H. and Anthony, E.L., (2001), *Dairy Cattle and milk production, Biotech*. Tata McGraw Hill Publishing Co.Pvt.Ltd., New Delhi.
11. Edwards, C.A., and Bother, B., (1996). *Biology of earthworms*, Chapman Hall Publication company.
12. ICAR, (1997), *Handbook of Animal Husbandry*– The Indian Council of Agricultural Research, New Delhi.
13. Banerjee G.C., (1992), *Poultry*, Oxford and IBH, New Delhi.
14. Jhingran, AVG, (1991), *Fish and Fisheries of India.* Hindustan Publishing Co. New Delhi.
15. James. N. Marner, (1975), *Principles of Dairy Processing,* Wiley eastern limited, New Delhi.
16. Baradach, JE. Ryther. JH. and, MC larney WO., (1972), *Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms*. Wiley InterScience, NewYork.

Web Resources

1. https://bit.ly/3tXHjk8
2. https://bit.ly/3tUTHBu
3. https://bit.ly/3hVv96q
4. https://bit.ly/39nztH1
5. https://bit.ly/3CzasVO
6. https://agritech.tnau.ac.in/org_farm/orgfarm_vermicompost.html
7. https://bit.ly/3nYvgSF
8. http://caa.gov.in/farms.html
9. http://www.csrtimys.res.in/
10. http://www.agshoney.com/training.htm

Course Outcomes (COs)

1. To identify the breeds and varieties of poultry, fish, bees, and cattle and understand the basic aspects of farming.
2. To assess and integrate the available tools and techniques to increase the productivity in farms.
3. To analyse the pros and cons of different methods of farming and marketing strategies of products.
4. To evaluate the use of available resources in improving the breeds, vermicomposting, farm products etc..
5. To design new methods to improve farm animals with increased productivity and disease resistance and to construct new methods in vermicomposting.

PART – IV

Skill Enhancement Course – SEC-4

4.2 MEDICAL LABORATORY TECHNIQUES

Hours: 2 Credit- 1

Learning Objectives

1. To understand the different protocols and procedures to collect clinical samples.
2. To explain the characteristics of clinical samples.
3. To demonstrate skill in handling clinical equipment.
4. To evaluate the safety precautions while handling clinical samples.
5. To summarise the control measures to avoid contamination of clinical samples.

Unit I: Laboratory Safety and Human Health and Hygiene: Laboratory safety –toxic chemicals and biohazards waste- biosafety level- good laboratory practice – hygiene and health issue – physiology effect of alcohol, tobacco, smoking & junk food & its treatment - biomedical waste management.

Unit II: Haematology: Composition of blood and their function- a collection of blood & lab procedure- haemopoiesis- types of anaemia- mechanism of blood coagulation- bleeding time- clotting time- determination of haemoglobin-erythrocyte sedimentations rate- packed cell volume- Total count of RBC & WBC- Differential count WBC- blood grouping and typing- haemostasis- bleeding disorder of man - Haemolytic disease of newborn, Platelet count, reticulocytes count, Absolute Eosinophil count.

Unit III: Medical Microbiology and Instrumentation Techniques: Definition and scope of microbiology- structure and function of cells - parasites - Entamoeba- Plasmodium- Leishmania and Trypanosome- Computer tomography (CT scan) – Magnetic Resonance imaging – flowcytometry – treadmill test – PET.

Unit IV: Medical Physiology: Cardiovascular system- Blood pressure - Pulse – regulation of heart rate, cardiac shock. Heart sounds, Electrocardiogram (ECG) – significance – ultra sonography- Electroencephalography (EEG).

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

Text Books

1. Godker, P. B. and Darshan, P, Godker, (2011), *Textbook of Medical Laboratory Technology*, Mumbai.

2. Guyton and Hall, (2000), *Text Book of Medical Physiology*, 10th edition, Elseiner, New Delhi.
3. Mukerjee, K.L, (1999), *Medical Laboratory Technology- Vol,I, II, III*. Tata MC GrawHill, New Delhi.

4. Sood, R., (2009), *Medical Laboratory Technology, Methods and interpretation,* Jaypee Brothers Medical Publishers (P) Ltd.

Suggested Readings

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

Web Resources

1. https://bit.ly/3tUs8In
2. https://bit.ly/2XKu7mT
3. https://bit.ly/3hNS1EP
4. https://bit.ly/2ZgrLga
5. https://bit.ly/3hTBO1b

Course Outcomes (COs)

1. Understand protocols and procedures to collect clinical samples for blood analysis and to study human physiology.
2. Explain the characteristics of clinical samples.
3. Demonstrate skill in handling clinical equipment.
4. Evaluate the haematological and histological parameters of biological samples.
5. Elaborate the role of medical laboratory techniques in the healthcare industry.

SEMESTER -III PART – IV

NAN MUDTHALVAN COURSE-2

POULTRY SCIENCE AND MANAGEMENT*

** Substitute paper exclusively for reappearance only*

COURSE OUTCOMES

Students will be able to
(i) Understand the domestication of fowls
(ii) Know the techniques of rearing and management of various breed
(iii) Acquire the knowledge on the diseases of poultry and the prophylactic measures

Unit – I

External features of fowls – skeletal system – digestive system – endocrine system – feathers – Respiratory system – reproductive system. Genetics of fowls: Breeds of fowls – inheritance of morphological characters (List of autosomal and sex linked character – breeding methods – systems of breeding – modern method of breeding.

Unit – II

Poultry industry in India– choosing commercial layers and broilers – Poultry housing – deep litter and cage system-merits and demerits.

Unit – III

Practical aspects of chick rearing –brooding management- grower and layers – management of broilers – lighting, summer winter management – debunking.

Unit – IV

Poultry Nutrition: Energy – protein and aminoacids – Vitamins – essential organic elements – Non – nutrition feed additives – feed stuffs for poultry – feed formation.

Unit – V

Diseases: Viral, bacterial, fungal and parasitic disease of poultry. Vaccines and vaccination programme.

Suggested Readings

1. Gopalakrishnan C.A and G.Murley Mohan Lal (1997), *Livestock and Poultry enterprises for rural development*, Vikash, New Delhi.
2. Gnanamani M.R., (1998), Modern *aspects of commercial poultry keeping*, Giri Publications, Madurai.
3. Banarjee G.C., (1992), *Poultry*, Oxford and IBH, New Delhi.
4. Chauhan H.V.S. and S.Roy, (2018), *Poultry diseases, diagnosis and treatment*, New Age International Pvt. Ltd.
5. John William S. (Ed) 2003. *Poultry for Sustainable Food Production and Livelihood*, Loyola Publication, Chennai.
6. Vegad J.L., (2018), *Poultry diseases: A guide for farmers and Poultry Professionals*, CBS

Web Resources

1. https://libguides.auburn.edu/PoultryScience
2. https://www.sciencedirect.com › journal › poultry-science
3. http://www.wpsa.com

B.Sc Zoology

Second Year
Semester – IV

Part	List of Courses	Credit	No. of Hours per week
Part-1	**Language** – Tamil / Other Languages	3	6
Part-2	**English**	3	6
Part-3	1. Core Course VII: **Genetics and Evolution**	4	4
	2. Core Course VIII: **Lab on Genetics and Evolution**	2	2
	3. Elective-IV (Generic /Discipline Specific): **Chemistry for Biological Sciences - II**	3	4
	4. Elective-IV Lab Course: **Systematic Analysis of Organic Compounds**	2	2
Part-4	Skill Enhancement Course – SEC-5: **Basics of Marine Biology / Wildlife Conservation and Management**	1	2
	Naan Mudhalvan Course-3 (Basic Course in Ornithology*) ** Substitute paper exclusively for reappearance only*	2	2
	Value Education	2	2
	Total	**22**	**30**

SEMESTER – IV
CORE COURSE - VII
GENETICS AND EVOLUTION

Course Code **CC7**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	GENETICS AND EVOLUTION	Core	Y	-	-	-	4	4	25	75	100
CO1	To understand inheritance patterns and the principles of heredity, modification and extensions of Mendel's basic principles and role of genetics in biology.										
CO2	To know the causes and effects of genetic variation and to gain Knowledge in linkage & recombination (crossing over) and chromosomal mutations.										
CO3	To Understand 'DNA' as the basic genetic material and regulation of gene expression.										
CO4	Interpret that the evolution process depends on genetic variation and know the major events in evolution..										
CO5	To perceive the micro evolutionary concepts and principle of macroevolution.										

UNIT	Details	No. of Hours	Course Objectives
I	**Mendel and his experiments** - Monohybrid and dihybrid cross - Laws of inheritance- Mendelian traits in Man- Non-Allelic gene	12	CO1, CO2

	interaction: Complete, incomplete and codominance- Allelic Gene interaction: Complementary genes, Lethal genes and Epistasis. Multiple Alleles: ABO Blood Group – Rh Blood group. Polygenic inheritance: Skin colour of Man. Sex determination in man and genic balance theory. Cytoplasmic inheritance: Kappa particles in paramecium- Genetic maternal effect in shell coiling of *Limnaea.*		
II	**Linkage**- Morgan's experiment, complete & incomplete linkage- Crossing over - types, mechanisms- chromosome mapping- interference and coincidence. Karyotype. Sex Linked Inheritance: X- X-linked (Haemophilia and Colour Blindness) & Y- linked (Hypertrichosis) inheritance. Non-disjunction- Chromosomal Aberrations- Structural & Numerical and translocation of chromosomes **Mutations:** Types, mutagens, and molecular basis of mutation.	12	CO1, CO2, CO4, CO5
III	**DNA as the genetic material-** experimental proof- DNA replication and repair mechanism- Fine structure of gene - Regulation of gene expression- operon concept (*Lac* operon)- Inborn errors of metabolism- Genetic counselling- Eugenics & Euthenics	12	CO1, CO2, CO3, CO4, CO5
IV	**Origin of life**: Synthesis of organic molecules, Urey-Miller experiment **Theories of Evolution**- Lamarckism, Neo Lamarckism, Darwinism, Neo-Darwinism, **Modern synthetic**- Morphological, physiological, biochemical, embryological and palaeontological evidence- Geological time scale-Fossil & Fossilisation- Types, Living and Extinct fossils.	12	CO1, CO2, CO4, CO5
V	**Speciation and isolating mechanism** - Isolating mechanisms - Modes of speciation, Genetic drift-Adaptive radiation-Hardy Weinberg equilibrium- Convergent, Divergent and Parallel evolution- Coevolution- Colouration and Mimicry - Evolution of Horse and Humans (Biological & Cultural).	12	CO1, CO2, CO4, CO5
	Total	**60**	

Course Outcomes		
On completion of this course, students will;		
CO1	Understand the basis of inheritance and expression of genes.	PO1
CO2	Correlate changes in genetic makeup and phenotypic changes in progeny.	PO1, PO3, PO5
CO3	Analyse the causes of variations in genetic material and predict the effect in a population using different techniques and understand 'DNA' as the basic genetic material and regulation of gene expression.	PO1, PO3, PO4, PO5, PO6
CO4	Interpret that process of evolution depends on genetic variation and know the major events in the evolution..	PO1, PO4, PO5,
CO5	Compile the factors contributing to gene expression changes and specify the changes contributing to evolution and perceive the micro evolutionary concepts and principle of macroevolution.	PO1, PO3, PO4, PO5, PO6, PO8

Text Books
(Latest Editions)

1	Guptha G. K., (2013), *Genetics Classical to Modern*, Rastogi publishers, Meerut.
2	Lewin B., (2008), *Genes IX,* Jones and Bartlett publishers.
3	Veer Bala Rastogi., (2019), *Text Book of Genetics*, Generic
4	Verma P.S and Agarwal V.K., (2006), *Cell Biology, Genetics, Molecular Biology, Evolution and Ecology,* S. Chand & Company Ltd.
5	Verma P. S. and V. K. Agarwal., (2018), *Genetics*, S. Chand & Company Pvt Ltd.
6	John C.Herron and Scott Freeman (2015), *Evolutionary analysis*. V Edition. Pearson Education
Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Cooper, Geoffrey M., 2018. The cell: A Molecular Approach, Eighth Edition, Oxford University Press.
2	Dadson E.O. (1960). Evolution: Process and Product. Reinhold Pub.
3	Dobzhansky T., 1982. Genetics and The Origin of Species, Columbia University.
4	Fletcher H and Hickey I., 2015. Genetics, IV Edition. GS, Taylor and Francis Group, New York and London.
5	Gardner, Anne. 2009. Human Genetics, Scion Publishing Ltd.
6	Klug, W. S., Cummings, M. R., Spencer, C. A., 2012. Concepts of Genetics. X Edition. Benjamin Cummings.
7	Lodish, Harvey, Arnold Berk *et al* .,2007. Molecular cell biology. 6th edition, W. H. Freeman.
8	Russel, Peter J. 2013. iGenetics: A Molecular Approach, Pearson.
9	Strickberger M. W., 1995. Genetics, Prentice Hall India Learning Private Limited.
Web Resources	
1	https://go.nature.com/2XE8V1q
2	https://bit.ly/3zoTt6B
3	https://bit.ly/2XAm7oa
4	https://bit.ly/2XEbhxi
5	https://bit.ly/3AB4bso
6	https://bit.ly/39pZSE4
7	https://www.genome.gov/genetics-glossary/Sex-Linked
8	https://www.vedantu.com/biology/mutagens

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems,

	Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2		M	S		S			M
CO3			S	S	S	S		S
CO4				S				
CO5			S	S	S	S		S

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

SEMESTER – IV
CORE COURSE - VIII
LAB ON GENETICS AND EVOLUTION

Course Code **CC8**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB ON GENETICS AND EVOLUTION	Core	-	-	Y	-	2	2	50	50	100

Learning Objectives	
CO1	To encourage the students to learn the usage of genetics experiments.
CO2	To know the causes and effects of mutations.
CO3	To encourage students to understand the significance of living fossils and know the contributions of famous evolutionists.
CO4	To identify the variation in the animal kingdom and its role in evolution.
CO5	To record the spotters and analyse the genetics and evolutionary theories.

UNIT	**Details**		**Course Objectives**
I	**GENETICS** 1. Breeding Experiment: Chi Square test to be illustrated with beads/ coin tossing a) Monohybrid Cross b) Dihybrid Cross. 2. Observation of Simple Mendelian traits in man – to be recorded. 3. Observation and study of Polygenic inheritance of quantitative traits to be interpreted in graphs:-		CO1

	a) height of students b) weight of students		
II	3. Identification of human blood groups to be analysed for the students 4. Culture of Drosophila and observation of mutants		CO2
III	**EVOLUTION** 1.Gene Frequency: Hardy -Weinberg law- Probability Experiment. 2. Adaptive radiation: Feet / Beak of Birds 3. Visit to an evolutionary significance place.		CO3
IV	**Spotters:** Normal karyotype in male and female, Down's syndrome, Klinefelter's syndrome, Turner's syndrome, Colour Blindness, Haemophilia, Hypertrichosis, Colouration and Mimicry: Lycodon and Krait; Stick insect, Leaf insect, and Animals of evolutionary significance: Peripatus, Archeopteryx, Limulus.		CO4
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO5

Course Outcomes		
CO1	Understand the basis of inheritance and expression of genes.	PO1
CO2	Illustrate and examine the changes in the genetic makeup and phenotypic changes in the progeny.	PO1, PO2
CO3	Compile the factors contributing to gene expression changes and specify the changes contributing to evolution.	PO4, PO6
CO4	Compare and distinguish the dissected internal organs of lower animals.	PO4, PO5, PO6
CO5	Prepare and develop the mounting procedure of economically important invertebrates.	PO3, PO8

Text Books (Latest Editions)	
1	Surya Nandan Meena, Milind Naik, (2019), *Advances in Biological Science Research: A Practical Approach*, Academic Press, New York, USA.
2	Michael Perlin, William Beckerson, Adarsh Gopinath, (2017), *Cell, Genetics, and Molecular Biology: A Lab Manual* (First Edition), Cognella Inc., USA.
3	Mammata Behera, Rinny Swain, Aditya Pratap Singh, (2024), *A Practical manual of fundamentals of Genetics*, Bigfoot Publications.
4	Stricberger, M.W., (1996), *Evolution.* Jones& Bartlett, USA
5	Dadson E.O. (1960), *Evolution: Process and Product*. Reinhold Pub.

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Robert F. Schleif, Pieter C. Wensink, (2012), *Practical Methods in Molecular Biology*, Springer-Verlag, NY, USA.
2	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, (2018), *Labster Virtual Lab Experiments: Basic Genetics*, Springer Publishers, NY, USA.
3	Harth and Jones EW. 1998. Genetics – Principles and Analysis. Jones and BarHett Publ. Boston.
4	Dr. Kishore R. Pawar, Dr. Ashok E. Desai, 2019. A text book of Organic Evolution, Nirali Prakashan,

5	Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company
Web Resources	
1	https://nbb.gov.in/
2	https://icar.org.in/
3	https://nisa.icar.gov.in/
4	https://www.nationalgeographic.com/animals/invertebrates/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

PART – IV

SKILL ENHANCEMENT COURSE – SEC-5

5.1 BASICS OF MARINE BIOLOGY

Hours: 2 Credit- 1

Learning Objective

1. To understand and learn the physical, chemical and biological aspects of marine environment and to gain knowledge about the management of oceans.
2. To introduce students to the marine environment and its indigenous organisms.
3. To study the principles, concepts and facts through which the student can better understand and appreciate the nature of the sea and its inhabitants.
4. To acquaint the student with the characteristics used to identify and classify marine plants and animals and to develop an awareness of the career possibilities available to students in this area.

Unit I: Marine Ecology : Marine environment- ecological factors- light, temperature, salinity, pressure; Classification of marine environment; Pelagic environment – Planktonic and Nektonic adaptations; Distribution and ecological role of other coastal environments -

coral reefs, estuaries, mangroves, seagrass beds, kelp forests polar seas and hydrothermal vents.

Unit II: Physical Oceanography : Physical Properties of Seawater- density, viscosity, surface tension, conductivity and their relationship; temperature distribution in the sea - heat budget, UV radiation; Dynamics of the ocean-general surface circulation, Waves, Currents and Tides, Tsunami.

Unit III: Chemical Oceanography : Chemical composition of seawater- ionic, major and minor constituents, constancy- ionic compositions and factors affecting constancy- major and minor elements, trace elements- their importance, distribution. Chemistry of seawater constituents- concept of chlorinity and salinity - methods of measurements, nutrients - biogeochemical cycles.

Unit IV: Biological Oceanography : Sea as a biological environment- Plankton- classification based on size, mode of life and habitat. Phytoplankton and Zooplankton - methods of collection, estimation of standing crop-wet and dry weight estimation-plankton volume settling and displacement methods.

Unit V: Marine Pollution and Ocean Management : Ocean pollution- kinds and quantities of pollutants, toxic effects and control measures – oil spills, plastics, nuclear waste disposal in marine environment, Eutrophication. Role of National and international agencies and organizations in ocean management-FAO, UNEP, DOD, WOCE, WHOI, IOI Malta, IMO INMARSAT- IUCN, SCAR, SCOR, Marpol, Traffic.

Visit to a marine diversity centre and writ a report.

Text Books

1. Thurman, Harold., (2001), *Introduction to Oceanography*, Prentice Hall Inc. New Jersey. 506 pp.
2. Bertness, M.D, S. D. Gaines and M.K. Hay (2000), *Marine Community Ecology* Sinauer Associates.
3. Grant Gross, M., (1993), *Oceanography: A view of the earth* (sixth edition). Prentice Hall Inc. New Jersey.
4. Fincham A. A, (1984), *Basic Marine Biology.* Cambridge University Press, England. 157 pp.
5. John Resech Jr. (1979), *Marine Biology.* Reston Publishing Company, Virginia. 257 pp.

Suggested Readings

1. Barbara E. Curry, (2016), *Advances in Marine Biology*, Volume 74, Ist Edition. Academic Press ISBN: 9780128036075
2. Peter Castro, Michael E. Huber, (2015), *Marine Biology; Series Botany, Zoology, Ecology and Evolution.* McGraw-Hill Education.
3. Philip V. Mladenov, (2013), *Marine Biology: A very short introduction*, Ist Edition. Oxford University Press.
4. Venkataraman K, Raghunathan C, Raghuraman R, Sreeraj C. R, (2012), *Marine diversity in India*. Zoological Survey of India, Kolkata.178 pp.
5. Amy Hill. (2002), *Marine Biology: An Introduction to Ocean Ecosystems* (Marine Biology Ser) Walch publishing.
6. Pickard, G.L. and W.J. Emery 1995. Descriptive Physical Oceanography. PergamonPress,London.
7. Gage. J.D. and P.A. Tyler, 1991. Deep Sea Biology, Cambridge University Press,Cambridge

8. Raymont J. E. G., 1980. Plankton and Productivity in the oceans: Volume 1: Phytoplankton, Pergamon Press.
9. Van Der Spoel, S. and PierrotBults, A. C (Eds) 1979.Zoogeography and diversity of plankton.Bungs Scientific Publishers Utrecht, 410pp.
10. Riley, J.P. and Skirrow, 1975-1984. Chemical Oceanography Vols. 1 to 8. Academic Press, London

Web Resources

1. https://www.livescience.com
2. https://www.icriforum.org
3. https://www.cbd.int

Course Outcomes (COs)

1. Define marine ecosystem, recognize and describe the interrelationship between biology and ocean technology.
2. Articulate and classify the dynamics and the physical attributes of the ocean, interpret the factors which affect the global climate.
3. Identify and analyze the physical and biological factors of marine environments, and focus life in the open sea.
4. Evaluate the impact of variations in abiotic factors in marine productivity and justify the role of human activities in the degradation of marine ecosystems.
5. Categorize marine pollutants and develop controlling measures in collaboration with the institutions for ocean management.

PART – IV

SKILL ENHANCEMENT COURSE – SEC-5

5.2 WILDLIFE CONSERVATION AND MANAGEMENT

Hours: 2 Credit- 1

Learning Objectives

1. To understand and discuss the importance of wildlife, its values, modern concepts in wildlife management, and relevant conservation policies.
2. To assess and instil strong foundations on wildlife policies and be familiar with a variety of laws and regulations.
3. To analyse and design appropriate approaches to turn conflict into tolerance and coexistence, with an emphasis on the human dimensions of human-wildlife interactions.
4. To evaluate and integrate all the related areas like Fundamentals in Ecology, Forestry, and Natural Resource Conservation approaches and develop the role PVA models for the protection of Endangered species.
5. To explain the advanced scientific basis for wildlife management and discuss National and International Efforts for successful wildlife conservation.

Unit I: Biodiversity Extinction and Conservation Approaches :
Perspectives and Expressions. Identification and prioritisation of Ecologically sensitive areas (ESA). Coarse filter and fine filter approaches. Regional and National approaches for biodiversity conservation.

Unit II: Theory and Analysis of Conservation of Populations:
Stochastic perturbations - Environmental, Demographic, spatial and genetic stochasticity. Population viability analysis-conceptual foundation, uses of PVA models. Management Decisions for small populations using PVA models. Minimum viable populations & recovery strategies for threatened species.

Unit III: National and International Efforts for Conservation:
International agreements for conserving marine life, Convention on Wetlands of International Importance (Ramsar Convention), Conservation of Natural Resources. Overview of conservation of Forest &Grassland resources. CITES, IUCN, CBD National Forest Policy, 1988, National Wildlife Action Plan 2017-2031, Wildlife Protection Act 1972, National and State Biodiversity Action Plans and other Forests and Environmental Acts.

Unit IV: Wildlife in India: Wildlife wealth of India & threatened wildlife, Reasons for wildlife depletion in India, Wildlife conservation approaches and limitations. Wildlife Habitat: Characteristic, Fauna and Adaptation with special reference to Tropical forest. Protected Area concept: National Parks, Sanctuaries and Biosphere Reserves,

Unit V: Management of Wildlife: Distribution, status. Habitat utilization pattern, threats to the survival of Slender Loris, Musk deer, Great Indian Bustard, Olive Ridley turtle. Wildlife Trade & legislation, Assessment, documentation, Prevention of trade, Wildlife laws and ethics.
Visit a Sanctuary or Biosphere reserve and write a report.

Text Books:

1. Robinson W L and Eric G Bolen, (1984), *Wildlife Ecology and Management,* Macmillan Publishing Company, New York, p 478.
2. Aaron, N.M. (1973), *Wildlife ecology*, W.H. Freeman Co. San Francisco, U.S.A.
3. Dasmann R F, (1964), *Wildlife Biology*, John Wiley & Sons, New York, p 231.
4. Justice Kuldip Singh (1998), *Handbook of Environment, Forest and Wildlife Protection Laws in India*, Natraj Publishers, Dehradun.
5. Hosetti, B.B. (1997), *Concepts in Wildlife Management*, Daya Publishing House, Delhi.
6. Sutherland, W.J (2000), *The conservation handbook: Research, Management and Policy*. Blackwell Science.
7. Caughley.G and Sinclaire, A.R.E (1994), *Wildlife ecology and management*. Blackwell Science.
8. Woodroffe R, Thirgood, S. and Rabinowitz A. (2005), *People and Wildlife, Conflict or Co-existence?,* Cambridge University.
9. Sinha, P.C. (1998), *Wildlife and Forest Conservation*, Anmol Publishing Pvt. Ltd., New Delhi.
10. Singh, S.K, (2005), *Text Book of Wildlife Management*. IBDC, Lucknow.

Suggested Readings

1. Gilas R H Jr.(ed.), (1984), *Wildlife Management Techniques*, 3rd ed. The Wildlife Society, Washington D.C., Nataraj Publishers, Dehra Dun, p 547.
2. Rodgers W A, (1991), *Techniques for Wildlife Census in India - A Field Manual: Technical Manual* - T M - 2. WII.
3. Saharia V B, (1982), *Wildlife of India,* Natraj Publishers, Dehra Dun.
4. Goutam Kumar Saha and Subhendu Mazumdar, (2017), *Wildlife Biology: An Indian Prospective,* PHI Publisher, Delhi.
5. Katwal/Banerjee, (2002), *Biodiversity conservation in managed and protected areas*, Agrobios, India.
6. Gopal, Rajesh, (1992), *Fundamentals of Wildlife Management, Justice Home,* Allahabad, India.
7. Sharma, B.D, (1999), *Indian Wildlife Resources Ecology and Development*, Daya Publishing House, Delhi.
8. Stephen, H.B. and V.B. Saharia, (1995), *Wildlife research and management*. Asian and American Approaches, Oxford University Press, Delhi.
9. Negi, S.S. (1993), *Biodiversity and its conservation in India*, Indus Publishing Co., New Delhi.
10. Moulton, M. P. & J. Sanderson, (1997), *Wildlife Issues in a Changing World*. St. Lucie Press.

Web resources

1. https://bit.ly/39oPj44
2. https://bit.ly/3lHdEYJ
3. https://bit.ly/3CwBCfY
4. https://bit.ly/3EDYr3a
5. https://bit.ly/3tVtG4U

Course outcomes (COs)

1. To understand and recall the importance of wildlife, extinction and Conservation Approaches of wildlife.
2. To integrate and assess the National, and international approaches for biodiversity conservation.
3. To analyse and differentiate threats to wildlife, various action plans, and conservation strategies on wildlife of India to turn conflict into tolerance and coexistence.
4. To explain the role of PVA models, Wildlife conservation approaches, and limitations.
5. To construct and simulate National and International strategies for Conservation, Wildlife laws and ethics.

SEMESTER -IV PART – IV

NAN MUDTHALVAN COURSE-3

BASIC COURSE IN ORNITHOLOGY*

** Substitute paper exclusively for reappearance only*

Learning Objectives

1. To equip students with the required knowledge to understand the taxonomic position and role played by birds in the ecosystem, their importance to humans and their evolution
2. To enable students to comprehend the biological evolution of birds and their structural adaptations
3. To enable students to understand and learn aspects of bird behaviour
4. To enable students to learn about the breeding biology of birds
5. To equip students with a knowledge of macroecology of birds, bird populations and communities, bird diseases, bird conservation and on the role of citizen science in ornithology.

Unit I

Introduction to Ornithology; Bird Lore; Birds and Humans; Classification of Birds, Bird Evolution and Speciation; Endemism

Unit II

External Morphology of the Bird; Structure of bird feather, Internal Structure of the Bird; Adaptations to Flight

Unit III

Bird Behaviour: Foraging, Roosting, Vocalization, Imprinting, Feather care, Bird Intelligence, Social Behaviour, Mixed Species Flocks, Migration

Unit IV

Breeding Biology: Differential investment of sexes; territoriality, courtship and display behaviour, nesting, eggs, incubation and care of young, brood parasitism

Unit V

Studying bird populations and communities, sampling methods; Macro ecology; Molecular Techniques in Ornithology; Avian Disease; Citizen Science and Ornithology; Threats faced by birds; Bird Conservation with case studies

Books For Reference

1. Lovette, I.J and Fitzpatrick, J.W. (2016). *Handbook of Bird Biology*, 3rd ed. Wiley.
2. Birkhead, T. (2013). *Bird Sense: What it's like to be a bird*? Bloomsbury, NY.
3. Birkhead, T., Wimpenny, J., and Montgomerie, B. (2014). *Ten Thousand Birds: Ornithology since Darwin.* Princeton University Press, Princeton, NJ.
4. Gill, F.B, and Prum, R.O. (2019). *Ornithology*, 4th ed. Macmillan.

Course Learning Outcome

On successful completion of the course, students will be able to

1. Recall the taxonomic position of birds, their external morphology and internal parts, types of bird behaviour, sampling methods and types of avian diseases.
2. Identify the external parts of the bird, internal structures of the bird and different types of bird behaviour
3. Differentiate birds based on their morphology, foraging strategies and other behaviour
4. Explain and discuss how birds evolved, bird adaptations to flight, different aspects of bird behaviour, threats to birds and the role of citizen science in ornithology
5. Discuss and analyse case studies relating to bird conservation

B.Sc Zoology
Third Year

Semester – V

Part	List of Courses	Credit	No. of Hours per week
Part-3	1. Core Course IX: **Animal Physiology and Biochemistry**	4	5
	2. Core Course X: **Environmental Biology**	4	5
	3. Core Course XI: **Lab on Animal Physiology and Biochemistry & Environmental Biology**	3	4
	4. Core Course XII: **PROJECT / Food, Nutrition and Health**	5	4
	5. Elective-V (Generic /Discipline Specific): **Biostatistics and Computer Application**	3	4
	6. Elective-VI (Generic /Discipline Specific): **1. Agricultural Entomology /** **2. Sericulture / 3. Vermitechnology**	3	4
	7. Elective Lab – V: **Lab on Elective -V and Elective -VI**	2	2
Part-4	Internship / Industrial Visit / Field Visit / Knowledge updation activity	2	0
	Naan Mudhalvan Course-4 (Basics of Marine Biology*) * *Substitute paper exclusively for reappearance only.*	2	2
	Total	**28**	**30**

SEMESTER – V
CORE COURSE - IX
ANIMAL PHYSIOLOGY AND BIOCHEMISTRY

Course Code **CC9**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ANIMAL PHYSIOLOGY AND BIOCHEMISTRY	Core	Y	-	-	-	4	5	25	75	100
CO1	To familiarise students with the principles and basic facts of Animal Physiology.										
CO2	To give students an insight into the molecular and cellular basis of animal physiological functions.										
CO3	To give an idea about the regulation of organ system functions in a whole animal using a conceptual model of feedback to explain homeostasis.										

CO4	To make the students aware of how the structure-function relationships and its synchronisation with the molecular signals.		
CO5	To help students gain knowledge in the basic structure of carbohydrates, fats and proteins and to understand the role of biomolecules in metabolism and learn the metabolic pathway.		
UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**Nutrition & Respiration** Nutrition: Gastrointestinal tract of man. Digestion - the role of enzymes and absorption of carbohydrates, proteins and lipids. Vitamins – their deficiency. Respiration: Structure of lungs in man. Respiratory pigments: structure of haemoglobin, Transportation and exchange of oxygen and carbon dioxide – Bohrs effect - bronchitis, asthma - Physiological effects of smoking.	15	CO1
II	**Circulation & Excretion** Blood- composition and functions, Mechanism of clotting. Types of Hearts – Heartbeat and its regulation - pacemaker – Cardiac cycle – ECG - Pulse and blood pressure. Structure of kidney Nephron structure & mechanism of urine formation, Excretory products.	15	CO2
III	**Neuromuscular Co-ordination** – Neuron – Structure, types of neurons - Nerve impulse – Synaptic transmission – Neurotransmitters. Reflex action, Nerve disorders – epilepsy, Alzheimer's disease, Parkinson's disease. **Muscles** –Structure and Types of Muscles –Physiological properties of muscle contraction- Biochemical events of muscle contraction.	15	CO3
IV	**Endocrine glands**- structure, secretions and functions of endocrine glands of vertebrates, Feed-back mechanism – Pituitary, Thyroid, Parathyroid, Adrenal, Thymus, Islets of Langerhans, Ovary and testis. **Receptors** – Chemoreceptors - Photoreceptors – mammalian eye – visual pigments – physiology of vision – phonoreceptors – mammalian Ear- Organ of Corti – working mechanism- - equilibrium receptors.	15	CO4
V	**Biochemistry:** Structure and Classification of Carbohydrates, Protein, Amino acids, Lipids. Enzymes: classification - mechanism of action. Metabolism: Glycogenesis– Glycogenolysis- Gluconeogenesis and Glycolysis, Kreb's cycle, Cori cycle; Deamination & Transamination; β - oxidation of fats.	15	CO5
	Total	**75**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Be able to explain how the various organ systems are coordinated and controlled.	PO1
CO2	Be able to list the functions of various organs in relation to physiological processes.	PO1, PO4

CO3	Be able to develop the idea of multi-level controlling and feedback mechanism in relation to various physiological functions.	PO4, PO6
CO4	Be able to understand the basic physiological process related to adaptation, metabolism and major requirements.	PO4, PO5, PO6,
CO5	Be able to gain knowledge in the basic structure of carbohydrates, fats and proteins and to understand the role of biomolecules in metabolism and learn the metabolic pathway.	PO3, PO8

Text Books
(Latest Editions)

1	Agarwal R A., Anil K Srivastava., Kaushal Kumar., (1978), *Animal Physiology and Biochemistry*, S. Chand & Co. Ltd., New Delhi Publishing.
2	Ambika Shanmugam, (2001), *Fundamentals of Biochemistry for Medical Students*, Karthik Offset Printers, Chennai.
3	Berry A.K.(1998), *A text book of Animal Physiology and Biochemistry*. Emkay Publications, New Delhi.
4	Parameswaran, Ananta Krishnan and Ananta Subramanian, (1975), *Outlines of Animal Physiology,* S. Viswanathan (Printers & Publishers) Pvt. Ltd., 329 p p.
5	Verma P.S., Tyagi B.S & Agarwal V.K., (2010), *Animal Physiology*, S. Chand & Co. Ltd., New Delhi Publishing., 417 pp.
6	Nelson, D.L. & Cox,M.M. (2017) *Lehninger principles of Biochemistry* (7th edition), W.H. Freeman and Co., New York.
7	Berg,J.M., Tymoczko,J.L. and Stryer,L. (2012) *Biochemistry* (7th edition) Freeman.

Reference Books
(Latest editions, and the style as given below must be strictly adhered to)

1	Guyton, A.C. and Hall, J.B., (2011), *Text Book of Medical Physiology*, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore.
2	Ganong, W.F., (2019), *Review of Medical Physiology*, McGraw Hill, New Delhi., 340 pp.
3	Hill, W.R., Wyse, G.A and Anderson, M. (2016), *Animal Physiology* (4thedn). Sinauer Associates Oxford University Press; USA, 828 pp.
4	Hoar, W.S. (1983), *General and Comparative Physiology*. Prentice Hall of India, New Delhi, 928 pp.
5	Prosser C.L., (1985), *Comparative Animal Physiology*, Satish Book Enterprise, Agra - 282 003, 966 pp.
6	Sarada Subrahmanyam, Madhavan Kutty, K., & Singh H.D., (2018). *Text Book of Human Physiology*, S. Chand & Co, New Delhi.
7	Singh, H.R and Kumar, N. (2017), *Animal physiology and biochemistry*, Vishal publishing company, Jalandhar.
8	Sreekumar, S. (2010), *Basic physiology*, PHI learning private ltd., New Delhi.210 pp
9	Tortora G.J. & Derrickson B., (2016), *Principles of Anatomy and Physiology*, John Sons, Inc.
10	Wood, D.W., (1968), *Principles of Animal Physiology,* Edward Arnold Ltd, London.
11	Zubay,G. (2017) *Biochemistry* (4th edition) McGraw-Hill.
12	Jain,J.L.(2001) *Fundamentals of Biochemistry*, Chandra &CO. Pvt. Ltd. New Delhi.

Web Resources

1	https://microbenotes.com/category/biochemistry/

2	https://www.stem.org.uk/resources/collection/3931/animal-physiology
3	https://animalphys4e.sinauer.com
4	https://nptel.ac.in/courses/102/104/102104042/
5	https://biochem.oregonstate.edu

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2		M						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – V
CORE COURSE - X
ENVIRONMENTAL BIOLOGY

Course Code **CC10**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ENVIRONMENTAL BIOLOGY	Core	Y	-	-	-	4	5	25	75	100
CO1	To create an awareness to the students about the theories, concepts and basics of Environmental Biology										
CO2	To provide students about the idea of biogeochemical cycles and energy flow in ecosystems										
CO3	To make an awareness of the fresh water habitat and marine habitat										
CO4	To provide adequate explanation to students about the pollutions and population ecology										
CO5	To give an idea about natural resources and conservation										

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**Ecosystem**: Concept of an ecosystem-Structure and function of an ecosystem- Producers, consumers and decomposers-Energy flow in the ecosystem-Ecological succession-Food chains, food webs and ecological pyramids- Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem-Grassland ecosystem-Desert ecosystem-Aquatic ecosystems (ponds, estuaries). Animal relationships: Mutualism, Commensalism, parasitism, Competition and Predation.	15	CO1
II	**Population Ecology**- Definition and characteristics: Density, Natality, Mortality, Migration, Emigration and Immigration, Population fluctuation- Age pyramid, growth and growth curve - factors affecting population growth -Carrying capacity. Population regulation and human population control.	15	CO2
III	**Environmental Stresses And Management**: Global climatic pattern, global warming, ozone depletion, Acid rain, Pesticides and other chemical in agriculture, industry and hygiene and their disposal. Bio indicator and biomarkers of environmental health. Biodegradation and bioremediation of heavy metals.	15	CO3
IV	**Environmental Pollution**: Definition- cause, effects and control measures of: -Air pollution - Water pollution -Soil pollution -Marine pollution - Noise pollution - Thermal pollution -Nuclear hazards.	15	CO4
V	**Biodiversity Conservation**: Biodiversity crisis – habitat degradation, poaching of wild life. - Socio economic and political causes of loss of biodiversity. - In situ and ex situ conservation of biodiversity -Hot spots of Biodiversity. Green	15	CO5

	peace movement - Chipko Movement - Role of government agencies: Central and State Pollution Control Boards - Ministry of Environment and Forests- National Biodiversity Authority. Awareness, Programme, NGOs, Natural Disaster Management, Legislations for environmental Protection.		
	Total	**75**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Be able to explain how the various organ systems are coordinated and controlled.	PO1
CO2	Be able to list the functions of various organs in relation to physiological process.	PO1, PO4
CO3	Be able to develop the idea of multi level controlling and feed back mechanism in relation to various physiological functions.	PO4, PO6
CO4	Be able to understand the basic physiological process related to adaptation, metabolism and major requirements.	PO4, PO5, PO6,
CO5	Be able to gain knowledge in the basic structure of carbohydrates, fats and proteins and to understand the role of biomolecules in metabolism and learn the metabolic pathway.	PO3, PO8

Text Books (Latest Editions)	
1	Agarwal R A., Anil K Srivastava., Kaushal Kumar., (1978), *Animal Physiology and Biochemistry*, S. Chand & Co. Ltd., New Delhi Publishing.
2	Ambika Shanmugam, (2001), *Fundamentals of Biochemistry for Medical Students*, Karthik Offset Printers, Chennai.
3	Berry A.K.(1998), *A text book of Animal Physiology and Biochemistry*. Emkay Publications, New Delhi.
4	Parameswaran, Ananta Krishnan and Ananta Subramanian, (1975), *Outlines of Animal Physiology,* S. Viswanathan (Printers & Publishers) Pvt. Ltd., 329 p p.
5	Verma P.S., Tyagi B.S & Agarwal V.K., (2010), *Animal Physiology*, S. Chand & Co. Ltd., New Delhi Publishing., 417 pp.
6	Nelson, D.L. & Cox,M.M. (2017) *Lehninger principles of Biochemistry* (7th edition), W.H. Freeman and Co., New York.
7	Berg,J.M., Tymoczko,J.L. and Stryer,L. (2012) *Biochemistry* (7th edition) Freeman.

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Guyton, A.C. and Hall, J.B., (2011), *Text Book of Medical Physiology*, 9th Edition, W.B. Sanders Company, Prism Books (Pvt.) Ltd., Bangalore.
2	Ganong, W.F., (2019), *Review of Medical Physiology*, McGraw Hill, New Delhi., 340 pp.
3	Hill, W.R., Wyse, G.A and Anderson, M. (2016), *Animal Physiology* (4thedn). Sinauer Associates Oxford University Press; USA, 828 pp.
4	Hoar, W.S. (1983), *General and Comparative Physiology*. Prentice Hall of India, New Delhi, 928 pp.
5	Prosser C.L., (1985), *Comparative Animal Physiology*, Satish Book Enterprise, Agra - 282 003, 966 pp.
6	Sarada Subrahmanyam, Madhavan Kutty, K., & Singh H.D., (2018). *Text Book of Human Physiology*, S. Chand & Co, New Delhi.

7	Singh, H.R and Kumar, N. (2017), *Animal physiology and biochemistry*, Vishal publishing company, Jalandhar.
8	Sreekumar, S. (2010), *Basic physiology*, PHI learning private ltd., New Delhi.210 pp
9	Tortora G.J. & Derrickson B., (2016), *Principles of Anatomy and Physiology*, John Sons, Inc.
10	Wood, D.W., (1968), *Principles of Animal Physiology,* Edward Arnold Ltd, London.
11	Zubay,G. (2017) *Biochemistry* (4th edition) McGraw-Hill.
12	Jain,J.L.(2001) *Fundamentals of Biochemistry*, Chandra &CO. Pvt. Ltd. New Delhi.
Web Resources	
1	https://microbenotes.com/category/biochemistry/
2	https://www.stem.org.uk/resources/collection/3931/animal-physiology
3	https://animalphys4e.sinauer.com
4	https://nptel.ac.in/courses/102/104/102104042/
5	https://biochem.oregonstate.edu

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2		M						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – V
CORE COURSE - XI
Lab on ANIMAL PHYSIOLOGY & BIOCHEMISTRY AND ENVIRONMENTAL BIOLOGY

Course Code **CC11**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB ON ANIMAL PHYSIOLOGY AND BIOCHEMISTRY AND ENVIRONMENTAL BIOLOGY	Core	-	-	Y	-	3	4	50	50	100

Learning Objectives	
CO1	To encourage the students to learn the usage of genetics experiments.
CO2	To know the causes and effects of mutations.
CO3	To encourage students to understand the significance of living fossils and know the contributions of famous evolutionists.
CO4	To identify the variation in the animal kingdom and its role in evolution.
CO5	To record the spotters and analyse the genetics and evolutionary theories.

UNIT	**Details**		**Course Objectives**
I	**Physiology:** 1. Rate of Oxygen consumption of fish 2. Effect of temperature on the Opercular movement of a fish – Calculation of Q_{10}. 3. Action of Salivary amylase in relation to enzyme concentration and temperature. 4. Demonstration of blood pressure using a Sphygmomanometer. 5. Qualitative test for Ammonia, Urea and Uric acid. 6. Protein estimation by Bradford method (Demo) 7. Qualitative tests for identification of carbohydrates, proteins and lipids.		CO1
II	**Ecology:** 1. Estimation of dissolved Oxygen – any 2 water samples. 2. Dissolved carbon-di-oxide – any 2 water samples 3. Estimation of total and phenolphthalein alkalinity – any 2 samples. 4. Determination of salinity of water samples, 5. Estimation of turbidity using Secchi disc. 6. Identification and mounting of any two marine / freshwater planktons		CO2

III	**Spotters / Charts:** **Physiology:** Intestinal villi, Haemoglobin, Myoglobin, neuron, Sphygmomanometer, Haemocytometer, ECG, Nephron, Cardiac muscle, striated muscle and Non-striated muscle, Thyroid gland, Adrenal, Glucose, Amino acid. **Ecology:** Mutualism: Hermit crab and Sea anemone, Commensalism: Echeneis and Shark, Parasitism: Sacculina on Crab, Predation: Snake and rat, Ecosystem – Pond, Food chain – Forest ecosystem, grassland ecosystem, age pyramid		CO3
IV	1. Visit to a local polluted site- Urban/ Rural/ Industrial/ Agricultural. 2. Study of a simple ecosystems - pond / river /hill slopes, etc. 3. Visit to Sanctuaries and National Parks – Report (Mandatory)		CO4
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO5

Course Outcomes		
CO1	Understand the basis of inheritance and expression of genes.	PO1
CO2	Illustrate and examine the changes in the genetic makeup and phenotypic changes in the progeny.	PO1, PO2
CO3	Compile the factors contributing to gene expression changes and specify the changes contributing to evolution.	PO4, PO6
CO4	Compare and distinguish the dissected internal organs of lower animals.	PO4, PO5, PO6
CO5	Prepare and develop the mounting procedure of economically important invertebrates.	PO3, PO8

Text Books (Latest Editions)	
1	Surya Nandan Meena, Milind Naik, (2019), *Advances in Biological Science Research: A Practical Approach*, Academic Press, New York, USA.
2	Michael Perlin, William Beckerson, Adarsh Gopinath, (2017), *Cell, Genetics, and Molecular Biology: A Lab Manual* (First Edition), Cognella Inc., USA.
3	Mammata Behera, Rinny Swain, Aditya Pratap Singh, (2024), *A Practical manual of fundamentals of Genetics*, Bigfoot Publications.
4	Stricberger, M.W., (1996), *Evolution.* Jones& Bartlett, USA
5	Dadson E.O. (1960), *Evolution: Process and Product*. Reinhold Pub.

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Robert F. Schleif, Pieter C. Wensink, (2012), *Practical Methods in Molecular Biology*, Springer-Verlag, NY, USA.
2	Sarah Stauffer, Aaron Gardner, Wilko Duprez, Dewi Ayu Kencana Ungu, Philip Wismer, (2018), *Labster Virtual Lab Experiments: Basic Genetics*, Springer Publishers, NY, USA.
3	Harth and Jones EW. 1998. Genetics – Principles and Analysis. Jones and BarHett Publ. Boston.
4	Dr. Kishore R. Pawar, Dr. Ashok E. Desai, 2019. A text book of Organic Evolution, Nirali Prakashan,

5	Minkoff, E. C. (1983). Evolutionary biology. Reading, MA: Addison-Wesley Publishing Company
Web Resources	
1	https://nbb.gov.in/
2	https://icar.org.in/
3	https://nisa.icar.gov.in/
4	https://www.nationalgeographic.com/animals/invertebrates/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – V
CORE COURSE - XII
9.1 PROJECT

Guidelines:

1. It shall be a Group activity with 4-6 students in each group.
2. A Group project report should be submitted at the end of 5th semester, during the practical examination.
3. The Group Project Report shall have a minimum of 25 to 100 pages.
4. Evaluation scheme for the Project - (50:50 for Internal: External)
5. The external examiner will evaluate the external 50 marks.

SEMESTER – V
CORE COURSE - XII

9.2 FOOD, NUTRITION AND HEALTH / (9.1PROJECT)

Course Code **CC9B**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	FOOD, NUTRITION AND HEALTH	Core	Y	-	-	-	5	4	25	75	100

Learning Objectives	
CO1	The course covers the basic concepts of a balanced diet for people of different ages besides focusing on the consequences of malnutrition and the deficiency diseases and the diseases caused due to poor hygiene.

UNIT	**Details**		**Course Objectives**
I	**Nutrition and dietary nutrients:** Basic concepts of Food: Components and nutrients. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people.	12	CO1
II	**Macro nutrients and micronutrients:** Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role. Micronutrients. Vitamins- Water-soluble and Fat-soluble vitamins- their sources and importance. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological functions.	12	CO1
III	**Malnutrition and nutrient deficiency diseases:** Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives.	12	CO1
IV	**Life style dependent diseases:** hypertension, diabetes mellitus, and obesity their causes and prevention. Social health problems- smoking, alcoholism, narcotics.AcquiredImmuno Deficiency Syndrome (AIDS): causes, treatment and prevention.	12	CO1
V	**Diseases caused by microorganisms:** Food hygiene: Potable water- sources and methods of purification at domestic level. Food and Water-borne infections: Bacterial diseases: cholera, typhoid fever - viral diseases: Hepatitis, Poliomyelitis - Protozoan diseases: amoebiasis, giardiasis - Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms	12	CO1

	and prevention. Causes of food spoilage and its prevention.		
Course Outcomes			
CO1	Students will be able to: ➢ Understand the role of food and nutrients in health and disease. ➢ Gain knowledge about hygiene, food safety, disease transmission. ➢ Perform food system management and leadership functions that consider sustainability in business, healthcare, community and institutional areas.	PO1, PO2, PO3,PO4, PO5, PO6, PO8	
Text Books (Latest Editions)			
1	Mudambi, S.R. and Rajagopal, M.V. (2007). *Fundamentals of Foods, Nutrition and Diet Therapy;* Fifth Ed;; New Age International Publishers.		
2	Srilakshmi, B. (2007). *Food Science*; Fourth Ed; New Age International (P) Ltd.		
3	Swaminathan, M. (1986). *Handbook of Foods and Nutrition;* Fifth Ed; BAPPCO.		
4	Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). *Text Book of Human Nutrition;* Oxford & IBH Publishing Co. Pvt Ltd.		
5	Lakra, P. and Singh M.D. (2008). *Textbook of Nutrition and Health*; First Ed; Academic Excellence.		
6	Gibney, M.J. et al. (2004). *Public Health Nutrition*; Blackwell Publishing.		
Methods of Evaluation			
Internal Evaluation	Continuous Internal Assessment Test	25 Marks	
	Assignment		
	Attendance and Class Participation		
External Evaluation	End Semester Examination	75 Marks	
	Total	**100 Marks**	

SEMESTER – V
ELECTIVE – V
BIOSTATISTICS AND COMPUTER APPLICATION

Course Code **EC5**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	BIOSTATISTICS AND COMPUTER APPLICATION	elective	Y	-	-	-	3	4	25	75	100

Learning Objectives	
CO1	To get the basic knowledge about collection and presentation of data
CO2	To calculate standard deviation, correlation coefficient, chi-square analysis and to understand hypothesis testing.
CO3	Use the technique to analyze the results of the experiments.
CO4	To gain basic knowledge about computers.
CO5	To acquire the knowledge about the office automation.

UNIT	**Details**		**Course Objectives**
I	**Introduction and Basics**: Definition and Scope: Population and Samples – Types of variables. Collection and sources of data: Primary and secondary data. Sampling methods & Sampling procedures. Classification and Presentation of data: Frequency distribution. Tabulation & Diagrammatic representation of data: tables - parts- types; diagrams – line diagram – bar diagram – pie diagram- histogram – graphs. Measures of Central tendency – Calculation of Mean, Mode and Median (Grouped and Ungrouped Data).	12	CO1
II	**Measures Of Dispersion**: Range, Standard Deviation and Standard Error, Variance, Coefficient of Variation. Hypothesis Testing- Null hypothesis- Level of significance - Chi–square test – Calculation and application, Students-t Test - Calculation and application.	12	CO2
III	**Correlation:** Introduction, Types, Perfect positive and negative, Linear and Non-Linear methods; Scatter diagram, Karl Pearson's correlation coefficient, Interpretation of the Correlation coefficient. Regression Analysis –Regression line, Regression equations.	12	CO3
IV	**Introduction to Computer** – Application of Computer – Generation of computer - Components of Computer: Input devices and Output devices – CPU – Memory: Primary and Secondary Memory - Operating system – Windows – Linux – Unix – Android. Multimedia, AI, Cyber Security.	12	CO4
V	**Introduction to Office Automation:** Word Processing: Open, Save and close a Word document; Edit text – formatting, bullets, Spell Checker - headers and footers, numbering, printing.	12	CO5

	Spreadsheets: MS Excel – entering and editing text and data – adjusting row and column height – Pie- bar- line chart preparation. PowerPoint: Introduction to PowerPoint – slide typecasting & viewing slides – creating slide shows. Uses of Internet – Email, Internet Browsing; e-learning tools & resources, World Wide Web (WWW).		

Course Outcomes		
CO1	Attach an insight on statistical methods for the analysis of biological data.	PO1
CO2	undertake statistical operations in biology.	PO1, PO2
CO3	Able to compare the data.	PO4, PO6
CO4	analyse and use the computers	PO4, PO5, PO6
CO5	gain basic understanding of computer hardware and software and use productive software's effectively.	PO3, PO8

Text Books (Latest Editions)	
1	Daniel, W.W. (2012) *Biostatistics: A Foundation for Analysis in Health Sciences* (10th edition) John Wiley.
2	Zar, J.H. (2013) *Biostatistical Analysis* (5th edition) Pearson.
3	Milton, J.S. and Tsokos, J.O. (1992) *Statistical Methods in the Biological and Health Sciences* (2 nd edition) McGraw Hill.
4	Gurumani,N. 2005. *Biostatistics,* 2 nd edition, MJP Publishers India.
5	Palanichamy, S and M. Shanmugavelu, (1991), *Principles of Biostatistics*. Palani Paramount. India.
6	Adabala N., and Rajaram, V. (2014), *Fundamentals of Computers*, PHI Learning
7	Peter Norton, (2002), *Introduction to Computers*, McGraw-Hill Education.

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Antonisamy, B., Solomon Christopher and P. Prasanna Samuel, (2011). *Biostatistics: Principles and practices.* MacGraw Hill Education Pvt. Ltd. New Delhi.
2	Daniel, W. W., (2000), *Biostatistics: A foundation for analysis in the health sciences,* 7thEd. John Wiley & Sons Ltd. New York.
3	MichaelC., Whitlock and Dolph Schluter, (2009). *The analysis of biological data,* 2ndEd. MacMillan Publishers, NewYork, USA.
4	Ronser,B., (2006), *Fundamentals of Biostatistics*, Thomson Brooks/Cole,6thEd. Duxbury press, Singapore.
5	Reema Thareja, (2019), *Fundamentals of Computers*, Oxford University Press.
6	Bright Siaw Afriyie, (2006), *Introduction to Computer Fundamentals,* Trafford Publishing.

Web Resources	
1	https://bit.ly/2VYWOM5
2	https://bit.ly/2VZQFiT
3	https://bit.ly/3kqdXYA
4	https://bit.ly/39rvvgt

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S			S			
CO3			S	S		S		
CO4				S	S	M		
CO5			S					S

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

ELECTIVE LAB - V

5 - BIOSTATISTICS AND COMPUTER APPLICATION - PRACTICALS

Practical:

1. Find out the Mean, Median, Mode, Standard deviation, Standard error and Coefficient of variance using serrations of neem leaves.
2. Calculation of correlation from Length and width of leaves.
3. Spotters: Bar diagram, Histogram, Pie diagram and Frequency curve and polygon, Computer Mouse, CPU, Keyboard, Monitor.
4. Visit to a Computer centre to learn internet browsing and email sending – Compulsory for each student.

SEMESTER – V
ELECTIVE - VI
5.1 AGRICULTURAL ENTOMOLOGY

Course Code **EC6A**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	AGRICULTURAL ENTOMOLOGY	elective	Y	-	-	-	3	4	25	75	100

Learning Objectives	
CO1	Explain the basic concepts of entomology and observe the pest status of agriculture.
CO2	Illustrate and examine the systemic and functional morphology of various group of agricultural insect pests.
CO3	Differentiate and classify the various groups of insect animals and estimate biodiversity.
CO4	To compare and distinguish the general and specific characteristics integrated pest management.
CO5	Infer and integrate the economic importance of insect species.

UNIT	**Details**		**Course Objectives**
I	Outline classification of insects - Causes for insect assuming pest status - Methods of collection, mounting and preservation of insect pests	12	CO1
II	Insect vectors of plant diseases, Insect pests of stored grains their preventive and curative methods, Most common insect pests of the following plants and their control measures: Paddy, Sugarcane, Groundnut, Coconut and Cotton. Locust and its control.Insect pollinators and scavenger.	12	CO2
III	Apiculture: Introduction, types of honey bees, hive, apiary, selection of bees for apiary, Newton's bee hive, enemies and diseases of honey bees. Sericulture: Introduction, types of silk worms, silk worm races, life history of mulberry silk worm, features of sericulture industry, pests and diseases of silk worm. Lac Culture.	12	CO3
IV	IPM, physical, mechanical, chemical and biological control methods, Pesticide application equipment.	12	CO4
V	Introduction and steps towards IPM, Pheromones, antifeedents, repellents and biopesticide.	12	CO5

Course Outcomes		
CO1	Examine and identify the systemic and functional morphology of various group of agricultural insect pests.	PO1
CO2	Differentiate and classify the various groups of insects and estimate the biodiversity.	PO1, PO2
CO3	Explain the pest status in agriculture and control measures.	PO4, PO6
CO4	To compare the methods and outcomes of integrated pest	PO4, PO5, PO6

	management.	
CO5	List the economic importance of agricultural insect species.	PO3, PO8
Text Books (Latest Editions)		
1	David,B and Ananthakrishnan,T.N. (2006), *General and Applied Entomology*, Second edition, Tata McGraw hill publishing company Ltd., New Delhi, India.	
2	Vasanthraj David, B. and Ramamurthy, VV. (2012), *Elements of Economic Entomology*, Seventh edition, Namrutha publications, Chennai.	
3	Pruthi,H.S. (1969), *Textbook on Agricultural Entomology*, I.C.A.R. Publication, New Delhi.	
4	Awasthi, V.B. (2012), *Introduction to General and Applied Entomology*, third edition, Scientific publishers.	
Reference Books (Latest editions, and the style as given below must be strictly adhered to)		
1	Abishek Shukla, D. (2009), *A Hand Book of Economic Entomology*, Vedamse Books, NewDelhi.	
2	Ministry of Agriculture, Government of India, (1995), *Manual on Integrated Pest Management in Rice and Cotton.*	
3	John William S. (1995), *Management of Natural Wealth,* Loyola College Publications, Chennai.	
Web Resources		
1	http://www.fao.org	
2	http://flybase.bio.indiana.edu/	
3	http://www.ipm.ucdavis.edu	
4	http://www.ent.iastate.edu/list/	
5	www.entsoc.org	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4		M		S	S	M		
CO5			S					S

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

SEMESTER – V
ELECTIVE - VI

5.1 AGRICULTURAL ENTOMOLOGY - PRACTICALS

1. Methods of collection of insects.
2. Study of insect segmentation, various tagmata and their appendages
3. Preparation of permanent mounts of different body parts and their appendages.
4. Dissection of silk glands, digestive and nervous system – silk worm.
5. Mounting of legs, mouth parts and sting of worker bees.
6. Report on a field visit to a Sericulture farm / Apiary farm (Mandatory)
7. Spotters: Rice stem borer (*Scirpophaga incestuous*), Pest of Sugarcane: The shoot borer (*Chilo infuscatellus*), Pest of coconut: The rhinoceros beetle (*Oryctes rhinoceros*), Locust, Newtons bee hive, Bee comb, queen bee, worker bee, silkworm egg, larva, pupa and adult, Chandrika and Netrika.

SEMESTER – V
ELECTIVE - VI

5.2 SERICULTURE

Course Code **EC5B**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	SERICULTURE	elective	Y	-	-	-	3	4	25	75	100

Learning Objectives	
CO1	Study the scope and importance of Sericulture for the betterment of human welfare.
CO2	Introduce the concepts of sericulture and mulberry cultivation.
CO3	To get deep knowledge on diseases of silk worm and pests of mulberry plants.
CO4	Understand the methods of harvesting, and cocoon marketing.
CO5	Adopt sericulture as a vocation as it is rural agro based based cottage industry.

UNIT	**Details**		**Course Objectives**
I	**Importance of sericulture:** Sericulture industry in India, sericulture as cottage industry, role of Central Silk Board, Moriculture, Mulberry varieties – High yielding varieties – Varieties for rainfed conditions. Morphology of mulberry plant, methods of propagation, irrigation, manuring – Biofertilizers – Green manuring – Triacontanol for increased mulberry productivity – Seriboost, pruning, harvesting and storing of mulberry leaves, package of practices for mulberry cultivation.	12	CO1

II	**Diseases of mulberry:** Fungal diseases – fungal root diseases, fungal shoot diseases, Bacterial diseases – leaf blight disease, rot disease, Viral disease – mulberry leaf mosaic disease, dawn disease, Neamatode disease - root knot disease, Deficiency diseases – nitrogen deficiency, phosphorus deficiency, potassium deficiency, magnesium deficiency and calcium deficiency. Pests of mulberry – leaf eating insect pests and borer pests one example each	12	CO2
III	**Classification of mulberry:** Silkworm, habit and habitats of silkworm, voltinism, races of silkworms, life cycle of mulberry silkworms, structure of egg, larva, pupa and adult, sexual dimorphism digestive system, circulatory system, excretory system, respiratory system, nervous system and reproductive system, endocrine glands, glands of silkworm.	12	CO3
IV	**Rearing of silkworm:** Rearing house – Rearing appliances – Rearing operation – Disinfection – Brushing – Maintenance of optimum conditions, Feeding – bed cleaning – spacing. Rearing of young ages – Chawki rearing - Rearing of late age larva: Shelf rearing. Floor rearing, shoot rearing. Application of sampoorna. Mounting: Methods – precautions, Cocoon marketing: Characteristics of cocoon – defective cocoons – methods of harvesting.	12	CO4
V	**Diseases of silkworm:** Protozoan – pebrine, Viral – Flacherie, gattine, grasserie Bacterial – Flacherie, septicemia, sotto, court, Fungal – Muscardine, Pests – Uzy fly, dermestid beetle of silkworm. Silk reeling: cocoon stifling – types, storage of stifled cocoons, sorting, cocoon, boiling and deflossing – brushing, Process of reeling: Different methods, silk waste and byproducts of silk reeling. Raw silk and marketing.	12	CO5

Course Outcomes		
On successful completion of the course the student will be able to		
CO1	Understand the scope of sericulture and mulberry cultivation practices.	PO1
CO2	Gain knowledge on diseases of silkworms and pests of mulberry.	PO1, PO2
CO3	Understand the classification, life cycle and physiology of silkworms.	PO4, PO6
CO4	Apply the rearing methods, harvesting of cocoon and cocoon marketing.	PO4, PO5, PO6
CO5	Decide to start sericulture unit / reeling unit in the local area and become notable entrepreneur.	PO3, PO8

REFERENCE BOOKS :

1 Ganga, G. and I. Sulochana Chetty, (2023), *An introduction to Sericulture*, Oxford &

	IBH Publishing Company Private Limited,S -155,Panchshila Park,NewDelhi.
2	Ganga,G. (2003*), Silkworm Rearing and Silk Realing (Comprehensive Sericulture, Volume – 2,* Science Publishers, US
3	Dandin, S.B, Jayant Jayaswal and K. Giridhas, (2003), *Hand Book of Sericultural Technologies*, Central Silk Board, Madivala, Bangalore –68.
4	Kamile Afifa. S and Masoodi M. Amin, (2004), *Principles of Temperate Sericulture*, Kalyani Publishers, B – 1/1292,Rajinder Nagar, Ludhiana.
5	Kesary, M and M.Johnson, (2019), *Sericulture*, (NMCC), Saras Publications.
6	Manisha B., (2019), *Economics of Sericulture*, Rajesh Publications.
7	Amardev Singh, (2013), Sericulture Extension, Biotech Books.

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S			M			
CO3			S	S		S		
CO4				S	S	M		
CO5			S					S

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

ELECTIVE VI
5.2 SERICULTURE PRACTICALS

1. Dissection of silk glands of a silkworm.
2. Dissection of the digestive system of a silkworm.
3. Dissection of the nervous system of a silkworm
4. Selection of mulberry leaves according to different stages.
5. Life history – egg, larva, pupa and adult.
6. Sexual dimorphism in larva, pupa and adult.
7. Mulberry varieties such as MR2, S30, S36,V2.
8. Chandrika
9. Netrikka
10. Rearing tray and reading stand.
11. Raw silk.
12. Report on a field visit to a sericulture farm.(Mandatory)

SEMESTER – V
ELECTIVE - VI
6.3 VERMITECHNOLGOY

Course Code **EC 6C**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	VERMITECHNOLOGY	elective	Y	-	-	-	3	4	25	75	100

Learning Objectives	
CO1	Gain the knowledge about the types of earthworms.
CO2	To understand the culture techniques of earthworms
CO3	Understand the production of vermicompost.
CO4	Understand the environment conservation process and its importance and protection of earthworms through vermiculture.
CO5	To gain the knowledge about the marketing of vermicompost.

UNIT	**Details**		**Course Objectives**
I	**Earthworm taxonomy:** Morphological and anatomical – Classification of earthworms – Food habits – Digestive system – Excretion – Reproduction and Life cycle – Earthworm as farmers friend.	12	CO1
II	**Types of earthworms:** Exotic and native species – South Indian and North Indian species used in Vermicomposting – Collection and Preservation of earthworms for vermicomposting – Culture techniques of earthworms.	12	CO2
III	**Vermicompost production:** – Requirements – Different methods of Vermicomposting – Heap method – Pot method and Tray method – changes during Vermicomposting.	12	CO3
IV	**Role of Earthworms in soil fertility:** Use of Vermicompost for crop production – Use of earthworms in land improvement and land reclamation – Economics of Vermicompost and vermiwash production. Earthworms as animal feed – Medicinal value of earthworm meal – Role of Earthworms in Solid Waste, Sewage and faecal waste management and Vermifilters. Earthworms as bioreactors.	12	CO4
V	**Interaction of earthworms:** Interaction of earthworms with other organisms – Influence of chemical inputs on earthworm activities – Large scale manufacture of Vermicompost, packaging of vermicompost and its marketing – Financial supporting – Government and NGOs for vermiculture work.	12	CO5

Course Outcomes		
CO1	Improve the knowledge for identification of earthworms.	PO1
CO2	Find out Vermicomposting is an eco-friendly, economically and socially acceptable technology	PO1, PO2
CO3	Apply Vermitechnology to convert the rural and urban garbage into nutrient rich ecofriently organic manure.	PO4, PO6
CO4	Justify and prove that the earthworms are having the capacity to observe heavy metals into their tissues.	PO4, PO5, PO6
CO5	Improve Vermitechnology to manufacture the vermicompost in small scale industry.	PO3, PO8

REFERENCE BOOKS :	
1	Bhatt J. V. & S. R. Khambata (1959), *Role of Earthworms in Agriculture*, Indian Council of Agricultural Research, New Delhi.
2	Edwards, C.A. and J.R. Lofty (1977), *Biology of Earthworms*, Chapman and Hall Ltd., London.
3	Clive A Edwards, (2004), *Earthworm Ecology*, CRC Press.
4	Rhonda L Edwards and Clive A., (2010), *Vermiculture Technology*, CRC Press Inc
5	Lee, K.E. (1985), *Earthworms: Their ecology and Relationship with Soils and Land Use*, Academic Press, Sydney.
6	Kevin, A and K. E .Lee (1989), *Earthworm for Gardeners and Fisherman*, (CSIRO, Australia, Division of Soils)
7	Satchel, J.E. (1983), *Earthworm Ecology*, Chapman Hall, London.
8	Wallwork, J.A. (1983), *Earthworm Biology*, Edward Arnold (Publishers) Ltd. London.
9	Christy, M. V. (2008), *Vermitechnology*, 1st edition, MJP Publishers.
10	Lekshmy, M. S., Santhi R. (2012), *Vermitechnology*, Sara Publications, New Delhi, India,

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2		S						S
CO3				S		S		
CO4	S			S	S	M		
CO5			S					S

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

ELECTIVE LAB - VI
6.3 VERMITECHNOLOGY - PRACTICALS

1. Comparison of morphology & life stages of Eisenia fetida & Eudrilus eugeniae.
2. Dissection digestive system of earth worm (Demo)
3. Dissection nervous system of earth worm (Demo)
4. Mounting of Body setae
5. Mounting of Peniel selate
6. Preparation of waste mix for Vermicomposting
7. Vermiwash preparation.
8. Report on a field visit Collection of native earthworms & their identification. (Mandatory)
9. **Spotters**: Eisenia fetida, Eudrilus eugeniae, Megascolex mauritti, Cocoon, Tunnel trap, Vermiwash, Vermifilter, Vermitech 200, Vermicompost pit, Vermi reactor, Enemies of earthworm: ant, centipede

PART – IV

Internship / Industrial Visit / Field Visit / Knowledge updation activity

Guidelines:

1. Evaluation scheme - Internal mark 50 and external mark 50
2. A report should be submitted during the practical examination at the end of the 5th semester.
3. A report shall have a minimum of 10 to 25 pages.
4. The external examiner will evaluate the external 50 marks.
5. Submit Attendance certificate along with the report.

PART – IV

NAN MUDTHALVAN COURSE-4

BASICS OF MARINE BIOLOGY*

** Substitute paper exclusively for reappearance only*

Learning Objective

1. To understand and learn the physical, chemical and biological aspects of marine environment and to gain knowledge about the management of oceans.
2. To introduce students to the marine environment and its indigenous organisms.
3. To study the principles, concepts and facts through which the student can better understand and appreciate the nature of the sea and its inhabitants.
4. To acquaint the student with the characteristics used to identify and classify marine plants and animals and to develop an awareness of the career possibilities available to students in this area.

Unit I: Marine Ecology: Marine environment- ecological factors- light, temperature, salinity, pressure; Classification of marine environment; Pelagic environment – Planktonic and Nektonic adaptations; Benthic environment - intertidal, interstitial and deep sea adaptations

Unit II: Physical Oceanography: Physical Properties of Seawater- density, viscosity, surface tension, conductivity and their relationship; temperature distribution in the sea - Dynamics of the ocean-general surface circulation, Waves, Currents and Tides, Tsunami.

Unit III: Chemical Oceanography: Chemical composition of seawater- ionic, major and minor constituents, constancy- ionic compositions and factors affecting constancy- major and minor elements, trace elements- their importance, distribution. Chemistry of seawater constituents- concept of chlorinity and salinity - methods of measurements, nutrients - biogeochemical cycles.

Unit IV: Biological Oceanography: Sea as a biological environment- Plankton- classification based on size, mode of life and habitat. Phytoplankton and Zooplankton - methods of collection, estimation of standing crop-wet and dry weight estimation-– estimation and factors affecting primary productivity.

Unit V: Marine Pollution and Ocean Management: Ocean pollution- kinds and quantities of pollutants, toxic effects and control measures – oil spills, plastics, nuclear waste disposal in the marine environment, and Eutrophication. Role of National and international agencies and organizations in ocean management, UNEP, DOD, WOCE, WHOI.

Text Books

1. Thurman, Harold., (2001), *Introduction to Oceanography,* Prentice Hall Inc. New Jersey.
2. Bertness, M.D, S. D. Gaines and M.K. Hay (2000), *Marine Community Ecology,* Sinauer Associates.
3. Grant Gross, M., (1993), *Oceanography: A view of the earth* (sixth edition). Prentice Hall Inc. New Jersey.
4. Fincham A. A, (1984), *Basic Marine Biology*, Cambridge University Press, England.
5. John Resech Jr. (1979), *Marine Biology*. Reston Publishing Company, Virginia.

Suggested Readings

1. Barbara E. Curry, (2016), *Advances in Marine Biology*, Volume 74, Ist Edition. Academic Press ISBN: 9780128036075
2. Peter Castro, Michael E. Huber, (2015), *Marine Biology; Series Botany, Zoology, Ecology and Evolution*. McGraw-Hill Education.
3. Philip V. Mladenov, (2013), *Marine Biology: A very short introduction*, Ist Edition. Oxford University Press.
4. Venkataraman K, Raghunathan C, Raghuraman R, Sreeraj C. R, (2012), *Marine diversity in India.* Zoological Survey of India, Kolkata.178 pp.
5. Amy Hill. (2002), *Marine Biology: An Introduction to Ocean Ecosystems* (Marine Biology Ser) Walch publishing.
6. Pickard, G.L. and W.J. Emery (1995), *Descriptive Physical Oceanography,* Pergamon Press, London.
7. Gage. J.D. and P.A. Tyler, (1991), *Deep Sea Biology,* Cambridge University Press, Cambridge
8. Raymont J. E. G., (1980), *Plankton and Productivity in the oceans*: *Volume 1:* Phytoplankton, Pergamon Press.

Web Resources

1. https://www.livescience.com
2. https://www.icriforum.org
3. https://www.cbd.int

Course Outcomes (COs)

1. Define marine ecosystem, recognize and describe the interrelationship between biology and ocean technology.
2. Articulate and classify the dynamics and the physical attributes of the ocean, interpret the factors which affect the global climate.
3. Identify and analyze the physical and biological factors of marine environments, and focus life in the open sea.
4. Evaluate the impact of variations in abiotic factors in marine productivity and justify the role of human activities in the degradation of marine ecosystems.
5. Categorize marine pollutants and develop controlling measures in collaboration with the institutions for ocean management.

B.Sc Zoology
Third Year
Semester – VI

Part	List of Courses	Credit	No. of Hours per week
Part-3	1. Core Course XIII: **Developmental Biology**	4	6
	2. Core Course XIV: **Microbiology and Immunology**	4	6
	3. Core Course XI: **Lab on Developmental Biology & Microbiology and Immunology**	3	4
	4. Elective-VII (Generic /Discipline Specific): **Animal Biotechnology and Bioinformatics**	3	5
	5. Elective-VIII (Generic /Discipline Specific): **Applied Zoology / Apiculture / Aquaculture**	3	5
	6. Elective Lab – V: **Lab on Elective -VII and Elective -VIII**	2	2
Part-4	**Naan Mudhalvan Course-5** (Aquarium Keeping*) ** Substitute paper exclusively for reappearance only.*	2	2
Part-5	Extension Activity (NSS / NCC / YRC / RRC / Sports / Youth Welfare activities)	1	-
	Total	**22**	**30**

SEMESTER – VI
CORE COURSE - XIII
DEVELOPMENTAL BIOLOGY

Course Code **CC13**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	DEVELOPMENTAL BIOLOGY	Core	Y	-	-	-	4	6	25	75	100
CO1	To create an awareness to the students about the theories, concepts and basics of Developmental Biology.										
CO2	To provide students about the idea of sex cells, fertilization, cleavage, differentiation and development of organs.										
CO3	To make an awareness of the induction, organizers and development of extra embryonic structures.										
CO4	To provide adequate explanation to students about the late embryonic developments and post embryonic development and ageing.										
CO5	To give an idea about teratogenesis, invitro fertilization, stem cells and amniocentesis to the students										

UNIT	Details	No. of Hours	Course Objectives
I	**Gametogenesis & Fertilization** Basic concepts of developmental biology. Structure& types of Spermatozoa, Mammalian egg - Egg membranes. types of egg - Spermatogenesis – Oogenesis. Fertilization – mechanism, theories and significance – Parthenogenesis.	18	CO1
II	**Blastulation & Gastrulation** Cleavage - Planes and Patterns, Factors controlling cleavage - Fate map and its construction. Blastulation (frog) – types of blastula. Morphogenetic movements - Gastrulation of frog & chick.	18	CO2
III	**Organogenesis** Development of Brain, Eye and Heart in frog. Development of Nervous system in chick. Development of Pro, Meso, and Metanephric kidneys. Foetal membranes in Chick. Placentation in Mammals.	18	CO3
IV	**Applied Embryology** Organizer concept –Structure – mechanism of induction and competence. Nuclear transplantation - teratogenesis – Regeneration: types - events and factors. Embryonic stem cells & significance. Methods to culture embryo	18	CO4
V	**Human embryology** Reproductive organs, Menstrual cycle and menopause - Pregnancy – trimesters – development. Erythroblastosis foetalis -Twins – types. Infertility – causes - Test tube baby and Assisted Reproductive Technology – Embryo transfer – Amniocentesis.	18	CO5
	Total	**90**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe and illustrate the significance of cellular processes in embryonic development.	PO1
CO2	Be able to relate the factors that contribute to the developmental process, construct fate maps and illustrate the steps in morphogenesis and organogenesis.	PO1, PO4
CO3	To correlate the involvement of specific cell types in the formation of specific organs and explain the importance of morphogens.	PO4, PO6
CO4	To distinguish between the different types of developmental mechanisms in various organisms and appraise the species-based differences in development.	PO4, PO5, PO6,
CO5	To justify and validate the role of environment and genetics in influencing embryonic development	PO3, PO8

Text Books
(Latest Editions)

1. Lewis Wolpert (2007), *Principles of development,* 3rd edition, Oxford University Press, New Delhi, India
2. Subramoniam, T. (2003), *Developmental Biology*, Narosa Publishing House, New

	Delhi, India.
3	Verma, P.S., Agarwal, V. K. (2010), *Chordate Embryology: Developmental Biology*, S. Chand & Company, New Delhi., India.
Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Gilbert S.F. (2010), *Developmental Biology*, Sinauer Associates, Massachusetts, USA.
2	Balinsky, B.I. (1970), *Introduction to Embryology*, Philadelphia & London, UK.
3	Berril, N.J. (1971), *Developmental Biology*, McGraw Hill, New York, USA.
4	Russ Hodge (2010), *Developmental Biology*, Facts on File, Inc., New York, USA.
5	Carlson, Bruce, M. (2009), *Human Embryology and Developmental Biology*, Elsevier, Philadelphia, USA
Web Resources	
1	https://www.ncbi.nlm.nih.gov/books/NBK10052/
2	https://www.cdc.gov/ncbddd/developmentaldisabilities/facts.html
3	https://anatomypubs.onlinelibrary.wiley.com/doi/full/10.1002/dvdy.20468
4	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5293490/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M			M				
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – VI
CORE COURSE - XIV
MICROBIOLOGY AND IMMUNOLOGY

Course Code **CC14**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ENVIRONMENTAL BIOLOGY	Core	Y	-	-	-	4	6	25	75	100
CO1	To become familiar with the foundation concepts of history of Microbiology.										
CO2	To gain the knowledge of bacterial and viral diseases.										
CO3	To gain knowledge of microbes in food and environment.										
CO4	To understand about different types of immunity and immune response.										
CO5	To appreciate about immunoglobulins and immunological techniques.										

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**History and Scope of Microbiology** – Whittaker's classification of microorganisms – Ultra structure – Salient features and classification of microbes (Bacteria, Virus, Actinomycetes and Fungi). Bacterial growth and nutritional requirements – culture techniques and types of culture media – media preparation. Staining of Bacteria.	18	CO1
II	**Medical microbiology**- study of common bacterial and viral diseases in man: Causative organisms, mode of transmission, pathogenicity, symptoms and preventive measures-Bacterial diseases - Typhoid, Tuberculosis, Leprosy, Syphilis. Viral diseases- Influenza, Poxviruses (Chicken pox) Hepatitis- B, AIDS, Corona (Covid-19), Rabies, Dengue.	18	CO2
III	**Food microbiology** - Microbial food spoilage, food poisoning, physico-chemical methods in food preservation. Dairy microbiology- Pasteurization, fermented milk products (Curd and Cheese). Industrial microbiology- Basic design of fermentor, industrial fermentation of ethanol, penicillin and enzymes. - Biology of Nitrogen fixation and nitrogen fixers.	18	CO3
IV	**Scope of Immunology** - Types of Immunity- innate and acquired- Organs involved in immunity – structure and functions- Cells involved in immune response - Immune response- Humoral and Cell-mediated immune response- Mechanism- Primary and secondary immune response.	18	CO4
V	**Immunoglobulins** - Structure, types, distribution and biological functions- Antigen-antibody reactions – agglutination-precipitation and immunodiffusion. Hypersensitivity -Types with examples- Autoimmune Diseases - Concept and types- Organ transplantation- types of graft, mechanism of allograft rejection- MHC- Classes- Vaccines- types, vaccination schedule-	18	CO5
	Total	**90**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Understand history, relevance of microbiology and classification of bacteria.	PO1
CO2	Understand the cause of various bacterial and viral disease and prevention.	PO1, PO5
CO3	Gain knowledge of various microbes related to food, environment and industries.	PO4, PO6
CO4	Will be able to understand the immune response and immunity.	PO4, PO5, PO6,
CO5	Learn the immunological techniques in detail.	PO3, PO8
Text Books (Latest Editions)		
1	Aneja K.R., (2022), *Experiments in Microbiology*, plant pathology, Tissue culture and Mushroom Cultivation, New Age International, New Delhi.	
2	Aneja K.R., (2022), *Experiments in Microbiology*, plant pathology, Tissue culture and Mushroom Cultivation, New Age International, New Delhi.	
3	Atlas R.M., (1988), *Microbiology – fundamentals and applications*, Macmillan Publishing Company, New York.	
4	Ravindra Nath, (1990), *Fundamentals of Biology Courses for Biotechnology*, - Vol.1, Special Bangalore University edition, Kalayani Publishers.	
5	Greenwood D, Richard CD, John S and Peuther F (1992), *Medical Microbiology*, 16th edition. ELBS, Churchill living stone.	
6	Kuby, J, Punt, J, Stranford, S, Jones,Pand Owen, J, (2018), *Immunology,* 8th Edition, W.H.Freeman Publishing, New York.	
7	Roitt, M, Peter J. Delves, Seamus J. Martin And Dennis R. Burton, (2017), *Essential Immunology*, 13th Edition, Wiley-Blackwell Publishing, USA.	
Reference Books (Latest editions, and the style as given below must be strictly adhered to)		
1	Alexopoulos C.J. and Mims C.W., (1996), *Introductory Mycology*, New Age International, New Delhi.	
2	Thomas M. Bell, (1965), *An Introduction to General Virology*, William Heinemann Medical books, London.	
3	Stanier R.Y., Ingraham J.L., (1999), *General Microbiology*, Prentice Hall of India Private Limited, New Delhi.	
4	Salle A.J., (2007), *Fundamental Principles of Bacteriology*, Tata McGraw – Hill Publishing Company Limited, New Delhi.	
5	Pelczar .J. Chan E.C.S. and Krieg N.R., (1986), *Microbiology*, McGraw Hill Book Company, New York.	
6	Benson Harold J, (2002), *Microbiological Applications*, WCB McGraw – Hill, New York.	
7	Brock T.D. and Madigan M.T., (2010), *Biology of Microorganisms*, Prentice Hall of India Private Limited.	
8	Collins CH, Patricia M, and Lyne JM (1995). *Collins and Lynes Microbiological Methods*, 7th edition. Grange, Butter Worth, Oxford.	
9	Cappucino JG and Sherman N (1996). *Microbiology, A Laboratory Manual*, 4th	

	edition. Benjamin Cumings Inc. California.
10	Pelczar MJ, Chan ECS and Krieg NR (1993). *Microbiology,* 5th edition, Tata McGraw Hill.
11	Madigan MT, Martinko JM and Parker J (2012). *Brock Biology of Microorganism*, 11th edition Prentice Hall International Inc. London.
12	Abul A. Andrew, Lichtman. H, Shiv. P, (2014). *Cellular And Molecular Immunology*, 8th Edition, Published By W.B. Saunders.
13	Chapel. H, Haeney. M, Misbah. S, And Snowden. N, (2006), *Essentials of Clinical Immunology*, 5th Edition. Blackwell Publishing.

Web Resources	
1	https://vlab.amrita.edu/?sub=3&brch=73
2	https://learn.chm.msu.edu/vibl/
3	https://mvi-au.vlabs.ac.in/
4	https://virtuallab.tlc.ontariotechu.ca/intro.php
5	https://biochem.oregonstate.edu
6	https://www.merlot.org/merlot/viewMaterial.htm?id=79694
7	https://WWW.AAAAI.ORG/
8	https://WWW.BSACI.ORG/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
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Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2		PO3	PO4	PO5	PO6	PO7	PO8
CO1	S								
CO2	M	M							
CO3				S	S		S		
CO4					S	S	M		
CO5	M			S					S

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

SEMESTER – VI
CORE COURSE - XIV
LAB ON DEVELOPMENTAL BIOLOGY & MICROBIOLOGY AND IMMUNOLOGY

Course Code **CC15**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	LAB ON DEVELOPMENTAL BIOLOGY & MICROBIOLOGY AND IMMUNOLOGY	Core	-	-	Y	-	3	4	50	50	100

Learning Objectives	
CO1	To know the systematic handling procedures and protocols.
CO2	To give importance to the microscopic examination of gametes and microbes.
CO3	To gain knowledge on the basic concepts and principles of techniques.
CO4	To familiarize the blood group identification and immunization.
CO5	To record the spotters and analyse experiments.

UNIT	**Details**		**Course Objectives**
I	**DEVELOPMENTAL BIOLOGY** 1. Mounting and Observation of live sperms of a vertebrate 2. Mounting and Observation of egg of a vertebrate 3. Temporary mounting and Observation of chick embryo development: 24, 48, 72 & 96 hours.		CO1
II	**MICROBIOLOGY** 1. Sterilization techniques – Preparation of Media 2. Isolation of bacteria by pure culture- streak plate- pour plate method. 3. Preparation of culture serial dilution technique. 4. Isolation of bacteria from various sources – soil / water / air. 5. Simple staining of bacteria. 6. Gram's staining of bacteria. 7. Microscopic examination of living bacteria - Hanging drop method. 8. Visit to a Microbiology lab and write a report.		CO2
III	**IMMUNOLOGY** 1. Identification of ABO blood grouping and Rh blood grouping among the students. 2. Lymphoid organs in Rat (Demonstration only)		CO3
IV	**Spotters:** Blastula of frog, Gastrula of frog, Chick embryo 24, 48, 72 & 96 hours, Discoidal, Cotyledonary, Zonary and Diffuse placenta, Autoclave, Hot air oven, Agar plate, Agar stab, Agar		CO4

	slant, Inoculation needle. T- Cell, B- Cell, Thymus, Bone marrow, Spleen, Lymph node (T.S / entire organ), Immunoglobulins - Ig G & Ig M.		
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO5

Course Outcomes		
CO1	recollect the fundamental procedure of Developmental Zoology, Microbiology & Immunology.	PO1
CO2	understand the principles and adopt the techniques for their future courses.	PO1, PO2
CO3	apply the theoretical knowledge of food preservation, fermentation and immunization schedule.	PO4, PO6
CO4	evaluate the present situation to check for any outbreak of contagious diseases.	PO4, PO5, PO6
CO5	conclude the prevalence of diseases in adverse conditions and able to formulate solutions to manipulate/ manage the dangerous situation.	PO3, PO8

Text Books (Latest Editions)	
1	Balnisky B.I. (2012), *An Introduction to Embryology*, W.B. Saunders and Co.
2	Berril NJ, Kars G (1986). *Developmental Biology*, McGrawHills.
3	Gilbert SF (2010), *Developmental Biology*, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
4	Dubey RC & Maheshwari DK, (2015), *A Textbook of Microbiology*, S. Chand Publishers, New Delhi.
5	Pelczar MJ, Chan EC, Pelczar MF. (2001), *Elements of microbiology*. McGraw-Hill International Book Company.
6	Delves PJ, Martin SJ, Burton DR, Roitt IM. (2017), *Essential immunology*. John Wiley & Sons.

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Majumdar NN. (2015), *Vertebrate embryology*, Tata McGraw-Hill, New Delhi.
2	Verma PS & Agarwal VK (2018), *Chordate Embryology*, S. Chand Publishers, New Delhi
3	Willey JM, Sherwood L, Woolverton CJ. (2001), *Prescott's microbiology*. Singapore: McGraw-Hill.

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – VI
ELECTIVE - VII
7.1 ANIMAL BIOTECHNOLOGY AND BIOINFORMATICS

Course Code **EC7**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ANIMAL BIOTECHNOLOGY AND BIOINFORMATICS	elective	Y	-	-	-	3	5	25	75	100
CO1	To impart the skills required to explain the protocols for genetically manipulating cells and produce transgenic animals.										
CO2	To encourage the use of the apt molecular techniques to evaluate and analyze animal traits and diseases at the genomic level and employ methods for easy taxonomical identification and classification for biodiversity and environmental studies.										
CO3	To study methods of transgenesis and to consider their use in improving animal husbandry and animal health.										
CO4	To motivate students to review the ethics and speculate on the environmental implications of animal biotechnological methods.										
CO5	To help students to gain knowledge about databases and applications of bioinformatics.										

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**Fundamentals of Biotechnology**: Definition, Scope and Importance of Biotechnology. Enzymes- Restriction enzymes – Enzymes useful for genetic engineering. Vectors: Plasmids-types, characteristic features, Plasmid vector: (pBR322, Ti Plasmid), Bacteriophage vector: (Lambda phage and M13), Cosmid, YAC; Animal vector: (SV40), Transposons as vectors. DNA Library.	15	CO1
II	**Techniques in Animal Biotechnology:** Gene cloning: steps in cloning, selection of clones. Introduction of recombinant DNA into host cells: prokaryotic and Eukaryotic animal cells	15	CO2

	(Transformation, Transfection, Transduction, Microinjection, Electroporation, Liposome fusion). Screening and selection of recombinants (Direct selection, Insertional inactivation, blue-white selection, Colony hybridization). Blotting techniques: Methods of different types of blotting (Southern, Northern and Western); DNA sequencing: Sanger method, PCR: principle, types and application. Gel electrophoresis.		
III	**Transgenic Animal Technology:** Transgenesis: Concept, transgenes, transgenic animal models - knock out mice, sheep-Dolly, Applications of transgenesis - animals as bioreactors. Superbug & bioremediation, Bioweapons. **Medical biotechnology:** Hybridoma technology -Monoclonal antibodies. Gene therapy: Ex vivo and in vivo, role in cancer treatment; CRISPR gene editing. Molecular markers: RFLP, RAPD, DNA fingerprinting and application.	15	CO3
IV	**Applications and Ethics:** Animal cell culture - Basic requirements and techniques of cell culture, natural and synthetic culture media, primary culture and cell lines; Stem cells: types, culture and applications. Organ culture: Artificial Skin. Industrial biotechnology: Basic concepts of fermentation, production of ethanol. Human genome project: Mapping of human genome, applications. Ethics: Socio-ethical problem, ethical implications. IPR.	15	CO4
V	**Bioinformatics:** Definition of Bioinformatics, Databases: Nucleotide sequence database: GenBank, EMBL, and DDBJ. - Protein sequence database: SWISS-PROT, UniProt, - Structural database: PDB. Sequence Alignment: Pairwise sequence alignment – Multiple sequence Alignment. Database similarity search tools: BLAST, FASTA. Protein structure visualizing tools: Rasmol, SPDB viewer, Scope and Applications of bioinformatics.	15	CO5
	Total	**75**	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	Describe the methodologies for handling animal cell cultures	PO1
CO2	Develop knowledge on techniques in cell culture	PO1, PO5
CO3	Know the methods and maintenance of embryo culture	PO4, PO6
CO4	Gain knowledge on stem cell therapy	PO4, PO5, PO6,
CO5	Understand the databases and applications of bioinformatics.	PO3, PO8

Text Books (Latest Editions)

1	Singh B. D., (2015), *Biotechnology: Expanding horizon*, Kalyani publishers.
2	Sasidhara, R., (2015), *Animal biotechnology*, MJP publishers.
3	Dubey R. C., (2014), *A text Book of Biotechnology*, S. Chand & Co Ltd, Ram Nagar, New Delhi.
4	Ruby, R.C., (2012), *A text book of biotechnology*, S. Chand Company, New Delhi.
5	Namita Mendirratta and P Rastogi, (2022), *Bioinformatics: Methods and Applications:*

	genomics, proteomics and drug discovery, PHI Learning.
6	Anna Tramontano, (2006), *Introduction to Bioinformatics*, Chapman & Hall/CRC.

Reference Books
(Latest editions, and the style as given below must be strictly adhered to)

1	Dubey S. K., Bandana Ghosh, (2012), *Fish biotechnology*, Wisdom Press.
2	Dubey R.C., (2014), *Advanced Biotechnology*, S. Chand Publication.
3	Ramdoss P., (2009), *Animal Biotechnology- Recent concepts and developments*, MJP publishers.
4	Sathyanarayran U., (2008), *Biotechnology*, Books and Allied, Kolkata.
5	Ignacimuthu, S., (2008), *Basic Biotechnology*, Tata McGraw hill, New Delhi.
6	Rastogi S. C., (2007), *Biotechnology: Principles and applications*, Alpha Science publishers.
7	Ranga, M.M., (2003), *Animal biotechnology*, Agrobios, New Delhi.
8	Sambamurthy K., Ashutosh Kar., (2009), *Pharmaceutical Biotechnology*, New Age International (P) Ltd.
9	Godbey W.T., (2014), *An Introduction to Biotechnology*, Academic press, New York, USA.
10	Peters, P., (2009), *Biotechnology – A guide to genetic engineering*, WMC brown publisher, UK.
11	Ramawat, K.G and Shailey Goyal, (2009), *Comprehensive biotechnology*, S.Chand company, New Delhi, India.
12	Primrose S.B., R. M. Twyman and R. W. Old, (2001), *Principles of gene manipulation,* Wiley- Blackwell, UK.
13	Primrose S. B., (2001), *Molecular Biotechnology*, Panima Publishing Corporation, New Delhi, India.
14	Hames B.D. and Higgins S.J. (1995). *Gene Probes: A Practical Approach*, Oxford University Press, UK.
15	Mount D. W., (2005), *Bioinformatics Sequence and Genome Analysis*, CBS.
16	Jin Xiong, (2007), *Essential Bioinformatics*, Cambridge University Press.
17	Hamid D. Ismail, (2022), *Bioinformatics,* Taylor & Francis Ltd.
18	Jonathan Pevsner, (2022), *Bioinformatics and Functional Genomics*, John Wiley.

Web Resources

1	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3612824/
2	https://www.isaaa.org/resources/publications/pocketk/40/default.asp
3	https://www.ncbi.nlm.nih.gov/books/NBK207574/
4	https://iopscience.iop.org/article/10.1088/1755-1315/492/1/012035/pdf
5	https://go.nature.com/3zAZmO9
6	https://www.biostars.org

Methods of Evaluation

Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	M						
CO3				S		S		
CO4		S		S	S	M		
CO5			S					S

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

ELECTIVE - VII
7.1 ANIMAL BIOTECHNOLOGY AND BIOINFORMATICS - PRACTICALS

PRACTICALS

1. Isolation of genomic DNA –Demonstration.
2. Isolation of Plasmid –Demonstration
3. Protein separation by PAGE (Poly acrylamide gel electrophoresis)– Demonstration.
4. Quantitative estimation of DNA by spectrophotometry
5. DNA separation by AGE (Agarose gel electrophoresis)- Demonstration.
6. Demonstration of PCR techniques
7. Sequence retrieval from databases (NCBI)
8. Multiple sequence alignment of the sequence – (using the online tool Clustal Omega)

Spotters /Models / Charts / Photos/:

PBR 322, Ti plasmid, Lambda Phage, Restriction enzyme, recombinant DNA, Electroporation, Microinjection, Southern blotting, RFLP, RAPD, Monoclonal antibody, Stem cells, Dolly, Laminar air flow, autoclave, Fermentor.
Take printouts from NCBI, EMBL, PDB, BLAST and keep them for spot tests.

SEMESTER – VI
ELECTIVE - VIII
8.1 APPLIED ZOOLOGY

Course Code **EC8A**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	APPLIED ZOOLOGY	elective	Y	-	-	-	3	5	25	75	100
CO1	To Know the different types of pests affecting crops and pest control methods.										
CO2	To know the insects of commercial importance and their economically important products.										
CO3	To gain the knowledge about the waste disposal.										
CO4	To gain knowledge of the various types of poultry breeds and their management										
CO5	To attain knowledge on the livestock development in India and its future prospects										
UNIT	**Details**							**No. of Hours**	**Course Objectives**		
I	**INSECT PESTS AND THEIR CONTROL** Definition of Pest- Causes for insects attaining pest status- Damage and loss due to pests. A brief account on pests affecting agricultural crops. Rice (Rice stem borer, Rice gall midge, Rice hopper), Sugarcane (Sugar cane leaf hopper, root borer, shoot borer), Cotton (Pink and spotted bollworm), Coconut (Rhinoceros beetle), Vegetables (Red pumpkin beetle, Cabbage butterfly, Hadda beetle (tomatoes and potatoes), Brinjal shoot borer), . Insect pests of stored grains (Rice weevil, Khapra beetle (wheat), Pulse beetle). Insect pest control methods (Physical, mechanical, chemical and biological), IPM							15	CO1		
II	**BENEFICIAL INSECTS** Sericulture- Mulberry and non-mulberry silkworms- common cultivable species- Biology of Bombyx mori- Types of silk. economic importance of silk Apiculture-Types of Honey bees for rearing- Bee hive products- Chemical composition, nutritional and medicinal value of honey. Lac Culture - Economic importance of lac insect							15	CO2		
III	**VERMICULTURE** Vermiculture- Selection of species for vermiculture – Vermicomposting- Organic resources for vermiculture - Vermicomposting methods (Pit Method and Heap Method)- Harvesting of vermicompost - Factors affecting vermicomposting. Advantages of vermicompost.							15	CO3		
IV	**POULTRY MANAGEMENT** Breeds of chicken- Indigenous breeds and exotic breeds (American, Asiatic, English and Mediterranean breeds) - Construction of poultry house- Intensive method of poultry rearing (Deep litter system and Cage system)- Feeding							15	CO4		

	equipment. Incubation of eggs (Natural and artificial). Diseases affecting poultry and their prevention methods.		
V	**DAIRY, SHEEP AND PIGGERY FARMING** Livestock development in India and its future prospects. Cattle breeds- (Dairy, Draught and Dual purpose breeds). Exotic breeds of cows. Buffalo breeds in India. Indigenous and exotic breeds of sheep for wool and meat production. Piggery - economically important breeds and economic importance.	15	CO5
	Total	**75**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	Describe the methodologies for handling animal cell cultures	PO1
CO2	To know the insects of commercial importance and their economically important products	PO1, PO5
CO3	Develop knowledge on techniques in waste management.	PO4, PO6
CO4	To gain knowledge of the various types of poultry breeds and their management	PO4, PO5, PO6,
CO5	To attain knowledge on the livestock development in India and its future prospects	PO3, PO8

Text Books (Latest Editions)	
1	B. Vasantharaj David and T. Kumaraswami (1982), *Elements of Economic Entomology*, Popular Book Depot, Chennai.
2	Nayar, K.K., Ananthakrishnan, T.N. and B.V. David,V (1992), *General And Applied Entomology*, Tata Mcgraw, New Delhi,
3	P.G. Fenemore, (2010), *Manual. Silkworm Rearing*. FAO Agricultural Service Bulletin, Rome.
4	Sukla, G.S. and Upadhyay, V.B., (2000), *Economic Zoology* – Rastogi Publications, Meerut, India.
5	Jawaid Ahsan and Subhas Prasad Sinha, (2000), *A Handbook On Economic Zoology*- S. Chand & Co., Ltd., New Delhi.
6	Ashok Kumar and Prem Mohan Nigam, (1991), *Economic and Applied Entomology*, Emkay Publications, New Delhi**.**

Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Shammi, Q.J. And Bhatnagar, S., (2002), *Applied Fisheries*, Agrobios (India), Jodhpur – India.
2	Major Hall, C.B. (2005), *Ponds and Fish Culture* - Agrobios (India), Jodhpur – India.
3	Keith Wilson, N.D.P., 2005 A Handbook of Poultry Practice –Agrobios (India), Jodhpur – India.
4	Banerjee, G.C. 1992 Poultry – Iii- Edition –Oxford & Ibh Publishing Co. Pvt. Ltd., New Delhi**.**

Web Resources	
1	https://semo.libguides.com/zoology
2	https://libguides.mssu.edu›c.php
3	https://www.classcentral.com

4	https://www.thebestwefind.com

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	M						
CO3			M	S		S		
CO4				S	S	M		
CO5	S		S					S

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

SEMESTER – VI
ELECTIVE - VIII

8.1 APPLIED ZOOLOGY - PRACTICALS

1. Methods of collection of insects.
2. Preparation of permanent mounts of different body parts and their appendages of insects.
3. Dissection of silk glands, digestive and nervous system – silk worm.
4. Mounting of legs, mouth parts and sting of worker bees.
5. Mounting of body setae of earthworm
6. Identification of exotic breeds of cows
7. Determination of adulterations in milk like water, urea.
8. Report on a field visit to a Poultry farm / Diary farm / Piggery farm (Mandatory)

Spotters: Rice stem borer (*Scirpophaga incestuous*), Pest of Sugarcane: The shoot borer (*Chilo infuscatellus*), Pest of coconut: The rhinoceros beetle (*Oryctes rhinoceros*), Newtons bee hive, Bee comb, queen bee, worker bee, silkworm egg, larva, pupa and adult, vermicompost, vermiwash, vermicompost pit, Ranikhet disease, fowl pox, coryza – diagrams or models, Ear tags, Pig pens, Pig waterer

SEMESTER – VI
ELECTIVE - VIII
8.2 APICULTURE

Course Code **CE8B**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	APICULTURE	elective	Y	-	-	-	3	5	25	75	100
CO1	familiarize the organization of bee colony										
CO2	know the systematic planning of apiary unit.										
CO3	get knowledge about the value of honey and harvesting techniques.										
CO4	understand the disease and enemies and behaviour of honey bees.										
CO5	provide rural based and welfare oriented knowledge.										

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	**INTRODUCTION** Definition, Scope, Classification of bees: Rock bee, Indian bee, Little bee and Dammer bee- their identification and habits, choice of species in Apiculture. Bee colony: Distinctive features, Identification and Functions of queen, drones and workers, Structure and functions of legs, mouth parts and sting of worker bee. Development of Honey bee: egg, larva and pupa-time taken for the development of queen, drone and worker. Food of the bee: bee bread, honey and pollen- royal jelly - propolis. Artificial feeding.	15	CO1
II	**PRINCIPLES OF APICULTURE** Arranging an Apiary: position- space- direction. Acquiring bees: care of newly captured colonies- handling the bees. Bee keeping: Primitive methods – their advantages and disadvantages. Different types of Modern hives: Architecture – Parts of artificial hive and its advantages – other appliances used in apiary The bee comb and its architecture-Different kinds of cells-Burr comb.	15	CO2
III	**HONEY BEE PRODUCTS** Honey: Collection and Extraction, Preservation and storage – Physical properties, Chemical composition, nutritive value, medicinal values- honey as daily food. Bee wax- Production - method of extraction- characteristics and uses. Bee venom- method of collection - composition of venom- its uses.	15	CO3
IV	**ENEMIES AND DISEASES OF BEES** Enemies: Greater wax moth, lesser wax moth, ants, wasps, lice, beetles, birds and their management. Diseases of bees: adult and brood diseases- Bacterial, Fungal, Viral & Protozoan- Prevention and Control measures.	15	CO4

V	**SWARMING AND OTHER BEHAVIOURS** Swarming- Prevention and control. Robbing and Fighting- Prevention and control. Uniting stocks- Different methods. Queen rearing. Supersedure. Foraging, interrelationships of plants and bees. Behaviour of bees- bee dances.	15	CO5
	Total	**75**	

Course Outcomes		
Course Outcomes	On completion of this course, students will;	
CO1	identify and characterize the members of the colony.	PO1
CO2	describe the structure and management of the colony.	PO1, PO5
CO3	adopt suitable methods to handle the bees safely.	PO4, PO6
CO4	plan to develop a modern apiary and marketing honey with self involvement and interest.	PO4, PO5, PO6,
CO5	motivate to start an apiary unit.	PO3, PO8

Text Books (Latest Editions)	
1	Mishra,R.(2002), *Perspectives in Indian Apiculture*. Anmol Publisher.
2	Abrol, D.P., (2020), *Beekeeping A Compressive guide to bees and beekeeping*, Scientific Publishers.
3	Abrol,D.P. (2010), *Bee and Bee Keeping in India.* Kalyani Publishers, B-1/1292, Rajinder Nagar,Ludhiana-141 008.
4	Cherian, M.C. & Ramachandran, (1952), *Bee Keeping in South India*, Department of Agriculture, Madras
5	Philips, E.F.(2018), *Bee Keeping*, Agrobios (India) behind NasraniCinema,Chopasani Road,Jodhpur-342 002.
6	Sadar Singh, (1962), *Bee Keeping in India,* ICAR, New Delhi.
7	Dharm Singh and Singh D.P., (2006), *Hand Book of bee Keeping*, Agrobios. Webb,A. (2007), Bee Keeping for profit and Pleasure, Agrobios (India).

Web Resources	
1	https://www.beesource.com/
2	https://www.betterbee.com/
3	https://www.honeyflow.com/pages/online-beekeeping-course

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate

	between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2		M						
CO3			S	S		S		
CO4	M			S	S	M		
CO5			S					S

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

ELECTIVE - VIII
8.2 APICULTURE - PRACTICALS

1. Mountings of legs,
2. Mounting of mouthparts
3. The mounting sting of worker bees.
4. Specimen, Model, Slide and Appliances: Queen, Worker, Drone, Artificial hive (Newton hive), Queen excluder, smoker, honey extractor, honey, scraffing knife, Bee comb, Bee veil and Comb foundation sheet.
3. Report on a field visit to the Apiary farm/ unit. (Mandatory)

SEMESTER – VI
ELECTIVE - VII
8.3 AQUACULTURE

Course Code **EC8C**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	AQUACULTURE	elective	Y	-	-	-	3	5	25	75	100
CO1	familiarize the aquaculture potential and practices in India.										
CO2	To gain the knowledge about preparation of ponds.										
CO3	impart knowledge on fish culture techniques to augment food production from aquatic resources.										
CO4	impart knowledge on health management, feed formulation and fish preservation										
CO5	To gain knowledge about the preservation techniques.										

UNIT	Details	No. of Hours	Course Objectives
I	**INTRODUCTION** Definition, scope of aquaculture, cultural techniques, Aquaculture in India - Freshwater, Coastal and marine aquaculture - Culturable organisms - Fin fishes, Shell fishes and their qualities.	15	CO1
II	**PREPARATION OF POND** Types of fish ponds. Nursery pond, rearing pond and culture pond. Fin fish culture - Culture of Indian major carp - Bundh breeding, Induced breeding, Transport of fish seeds. Shell fish culture Culture of marine prawn - Induced breeding - Types of prawn culture in India. Edible Oyster culture and Pearl Oyster culture.	15	CO2
III	**TYPES OF CULTURE PRACTICES** Extensive, Semi-intensive and Intensive culture, Monoculture, Monosex culture, Polyculture, Cage culture, Pen culture. Integrated fish farming - Paddy cum fish culture. Animal husbandry cum fish culture, Sewage fed fish culture.	15	CO3
IV	**FISH FEED AND DISEASES** Artificial feed: feed formulation, feed ingredients, pellets. Live feeds and their culture: Artemia, Diatoms, Rotifers, Micro Algae. Parasites and Diseases of aquaculture organisms: Ectoparasites and Endoparasites, Bacterial, Viral and Fungal diseases - Nutritional deficiency diseases.	15	CO4
V	GOV**ERNMENT BOARDS AND MARKETING** CMFRI, CIFRI, MPEDA, FFDA. Post-harvest technology in fishes - Rigor mortis, fish spoilage, fish preservation techniques - freezing, canning, drying. Fish marketing, Co-operative marketing in fisheries. Craft and gears. Water quality management.	15	CO5
	Total	**75**	

Course Outcomes

Course Outcomes	On completion of this course, students will;	
CO1	understand the biology and culture techniques of commercially important food fishes.	PO1
CO2	analyse the basic culture methodologies of culturable species and integrated fish farming.	PO1, PO5
CO3	identify common diseases, manipulation of condition factors and to apply health management measures.	PO4, PO6
CO4	Acquire knowledge on feed organisms and feed formulations. apply principles to handle the problems encountered in commercial production if self employed with an aquaculture unit.	PO4,PO6,
CO5	interpret different techniques of processing, preservation and marketing of fish.	PO3, PO8

Text Books (Latest Editions)	
1	Jhingaran, V.G. (1997), *Fish and Fisheries of India*, Hindustan Publishing Corporation (India), Delhi.
2	Srivastava, C.B.L. (2006), *A Text Book of Fishery Science and Indian Fisheries.* Kitab Mahal Distributors, 28, Netaji Subash Marg, New Delhi – 110002
3	Beavan, R. (2021), *Handbook of Freshwater Fisheries on India*. Narendra Publishing House, 1417, Kishan Dutt street, Maliwara, Delhi - 110 006.
4	Biswas, K.P. (2007), *Prevention and control of fish and prawn diseases*, Narendra Publishing 2 House, 1417, Kishan Dutt street, Maliwara, Delhi - 110 006.
Reference Books (Latest editions, and the style as given below must be strictly adhered to)	
1	Dash, M.C. & P.N. Patnik, (1994), *Brackish Water Prawn Culture*, Palani Paramount Publications,69-D., Anna Nager, Palani – 624602.
2	Dick Mills, (1992), *Tropical Aquarium Fishes*, Chancellor Press, Michelin House, 81, Fulham Road, London.
3	Khanna, S.S. and Kapoor N., (2019), *An Introduction to Fish Biology and Fisheries*, Surjeet Publications.
4	Latha Shenoy, (2001), *Course Manual in Fishing Technology*, Central Institute of Fisheries Education (ICAR), Versova, Bombay - 400061.
5	Mary Chandy, (2013), *Fishes*. National Book trust. A-5,Green Park, New Delhi-110016.
6	Pandian, T.J., (2015), *Sustainable India Fisheries,* National Academy of Agricultural Sciences. ICAR, Ministry of Agriculture, New Delhi.
7	Felix Betsy, (2019), *Principles of Aquaculture: Practical Manual*, Narendra Publishing House.
8	Lucas, J.S., Southgate, P.C., (2019), *Aquaculture:Forming Aquatic Animals and Plants,* Wiley-Blackwell.
9	Soderberg R., (2020), *Aquaculture Technology*, CRC Press.
10	Parihar, R.P. (1994), *A Text Book of Fish Biology and Indian Fisheries.* Central Publishing House, Allahabad.
11	Rath, R. K. (2011), *Freshwater Aquaculture.* Scientific Publishers. 5A.New Pali Road, Jodhpur, 342001
12	Bhosale M.M., and Mugale R.R. (2023), *Basic Principles & Practices in Aquaculture*, Narendra Publishing House.

of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	M		S				
CO3				S		S		
CO4		S		S	S	M		
CO5			S					S

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

ELECTIVE - VII

8.3 AQUACULTURE - PRACTICALS

1. Determination of pH in two water samples.
2. Estimation of Salinity.
3. Estimation of dissolved oxygen.
4. Estimation of alkalinity in two samples
5. Mounting Placoid, Cycloid and Ctenoid scales.
6. Field visit to Aquaculture unit / Fish farm – Report (Mandatory)
7. Spotters, Slides, models and Charts:
   Catla, Rogu, Mirgal, Channa, Penaeus, Crossostrea, Raft culture, Pinctada, Argulus, Lernaea, Marine and freshwater prawn.

PART – IV

NAN MUDTHALVAN COURSE-5
AQUARIUM KEEPING*

** Substitute paper exclusively for reappearance only*

Learning Objectives

- To create knowledge on self-employment opportunities based on ornamental fish culture.
- To provide knowledge of ornamental fishes and their equipment
- To understand the different breeding techniques of ornamental fishes

UNIT I

Introduction and scope - Aquarium fishkeeping as a hobby and cottage industry. Commercial aspects like national and international markets. To create knowledge on self-employment opportunities.

UNIT II

External morphology of a typical fish. Exotic and endemic varieties of ornamental fishes.

UNIT III

Aquarium preparation and maintenance - Kinds of tanks, tank setting, biological filter and aeration, water management, planting, lighting and feeds. Budget for setting up an Aquarium Fish Farm as a Cottage Industry

UNIT IV

Live fish transport- handling, feeding and forwarding techniques of fish. Fish Diseases and their control.

UNIT V

Breeding – Common characters and sexual dimorphism of Fresh water and Marine aquarium ornamental fish varieties such as Guppies, Mollies, Sword tails, Platy, Siamese fighters and Gold fish, Butterfly fish, Blue morph and Anemone fish.

REFERENCE BOOKS:

1. Santhanam, P., Sukumaran, N. & P. Natarajan, (1987), *A manual of freshwater aquaculture*, Oxford & IBH Publishing Company Pvt., Ltd., New Delhi.
2. Cliff Harrison, (1980), *A colour guide to Tropical Fish*, Chartwell Books, INC, Cerkshire, printed in Hon Kong.
3. O'Connell, R. F., (1977), *The freshwater aquarium*, Arco Publishing Company, INC New York.
4. JingranV.G., (1991), *Fish and Fisheries in India*, Hindustan Publ.Co. New Delhi
5. Mill Dick, (1993), *Aquarium Fish*, Daya Pub.co., New Delhi

Course Outcome:

- Students to learn about different ornamental fishes and identify the diseases of them
- To develop entrepreneur potential in the field of aquarium and get self-employment.

ELECTIVE / GENERIC COURSE /
Allied Zoology /
Industrial Fish and Fisheries-I

2024-2025 onwards

ELECTIVE / GENERIC COURSE

Semester – I

ALLIED ZOOLOGY - I

Course Code **EC1**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	INVERTEBRATA	Core	Y	-	-	-	3	4	25	75	100
CO1	To acquire a basic knowledge of diversity and organization of Protozoa, Coelenterata, Helminthes and Annelida										
CO2	To acquire a basic knowledge of diversity and organization of Arthropoda, Mollusca and Echinodermata										
CO3	To comprehend the taxonomic position and diversity among Protochordata, Pisces and Amphibia										
CO4	To comprehend the taxonomic position and diversity among Reptilia, Aves and Mammalia										
CO5	To acquire detailed knowledge of select invertebrate and chordate forms										
UNIT	**Details**							**No. of Hours**		**Course Objectives**	
I	**Diversity of Invertebrates–I** Principles of taxonomy. Criteria for classification–Symmetry and Coelom–Binomial Nomenclature. Classification of Protozoa, Coelenterata, Helminthes and Annelida upto classes with two examples.							12		CO1	
II	**Diversity of Invertebrates–II** Classification of Arthropoda, Mollusca and Echinodermata upto class level with examples							12		CO2	
III	**Diversity of Chordates–I** Classification of Prochordata, Pisces and Amphibia upto orders giving two examples.							12		CO3	
IV	**Diversity of Chordates–II** Classification of Reptilia, Aves and Mammalia upto orders giving two examples.							12		CO4	
V	Animal organization Structure and organization of (i) Earthworm (ii) Rabbit (iii)Prawn							12		CO5	
	Total							**60**			

Course Outcomes		
Course Outcomes	On completion of this course, students will	
CO1	Recall the characteristic features invertebrates and chordates.	PO1
CO2	Classify invertebrates up to class level and chordates up to order level	PO1, PO2
CO3	Explain and discuss the structural and functional organisation of some invertebrates and chordates	PO4, PO6
CO4	Relate the adaptations and habits of animals to their habitat	PO4, PO5, PO6
CO5	Analyse the taxonomic position of animals.	PO3, PO8
Text Books (Latest Editions)		
1	Ekambaranatha Iyer, 2000. *A Manual of Zoology*, 10th edition, Viswanathan, S., Printers & Publishers Pvt Ltd	
2	Jordan, E.L. and Verma P.S, 1995. *Invertebrate Zoology*, 12th edn. S. Chand& Co.	
3	Kotpal, R.L, 1992. *Protozoa, Porifera, Coelenterata, Annelida, Arthropoda, Mollusca, Echinodermata.*	
Reference Books (Latest editions, and the style as given below must be strictly adhered to)		
1	Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.	
2	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science	
3	Barrington, E.J.W. (1979). *Invertebrate Structure and Functions*, II Edition, E.L.B.S. and Nelson	
4	Hyman L.H, 1955. The invertebrates - Vol. I to Vol. VII – Mc Graw Hill Book Co.	
5	Parker, J. and Haswell , 1978. *A text book of Zoology Vol. I* - Williams and Williams.	
Web Resources		
1	https://www.nationalgeographic.com/animals/invertebrates/	
2	https://www.britannica.com/science/parasitic-disease	
3	https://www.nio.res.in/	
4	https://greatbarrierreef.org/	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**
Methods of Assessment		
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions	
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or	

	overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – I

ALLIED ZOOLOGY LAB COURSE - I

Course Code **EC2**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ALLIED ZOOLOGY LAB COURSE - I	Core	-	-	Y	-	2	2	50	50	100
Learning Objectives											
CO1	To understand the structure and label the various parts of the dissected organisms and to sketch the required system using virtual dissections, charts and web resources.										
CO2	To compare and discuss the differences in the mouth parts of cockroach and mosquitos by mounting and drawing										
CO3	To identify and discuss the significance of pigeon feather. To identify and understand the different invertebrate and chordate forms and classify them using lab manuals										
CO4	To compare and criticise various types of invertebrate and chordate animals.										
CO5	Analyse the campus fauna enables them to understand, identify and classify the various fauna surrounding them. It also enables them to compile all the data and to discuss the importance of conservation of fauna										

UNIT	Details		Course Objectives
I	**Dissection:** **1.** Cockroach – digestive system **2.** Cockroach – nervous system **3.** Fish – digestive system (sardine or any other fish)		CO1
II	**Mounting:** **1.** Mouth Parts – Cockroach **2.** Mouth Parts – Mosquito/ Honey bee **3.** Scales – Placoid, Cycloid and Ctenoid **4.** Prawn appendages		CO2
III	**Spotters:** *Paramecium, Plasmodium,* Scypha, *Leucosolenia,* Corals. *Taenia solium* –entire, *Ascaris* male and female. Earthworm, Prawn ,Scorpion, Pila, Starfish, Amphioxus, Shark, Frog, Calotes, Pigeon feather and Rabbit.		CO3, CO4
IV	**Field visit** – Study of fauna on the campus		CO5
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO5

Course Outcomes		
Course outcomes	On Completion of this course, student will;	
CO1	Compare and distinguish the dissected internal organs of lower and higher animals.	PO1
CO2	Prepare and develop the mounting procedure of important invertebrate and chordate anatomical parts and to appreciate the structure, function and mode of life.	PO1, PO2
CO3	Identify and label the external features of different groups of invertebrate animals.	PO4, PO6
CO4	Identify and label the external features of different groups of chordate animals.	PO4, PO5, PO6
CO5	Understand and apply the theoretical knowledge. To plan the area of research and to identify different groups of invertebrate and chordate animals.	PO3, PO8

Text Books
(Latest Editions)

1	Ekambaranatha Iyyar and T. N. Ananthakrishnan, 1995 *A manual of Zoology Vol.I* (Part 1, 2) S. Viswanathan, Chennai
2	Ganguly, Sinha an d Adhikari , 2011 . *Biology of Animals: Volume I,* New Central Book Agency; 3rd revised edition. 1008 pp.
3	Sinha, Chatterjee and Chattopadhyay, 2014. *Advanced Practical Zoology*, Books & Allied Ltd; 3rd Revised edition, 1 07 0 pp.
4	Lal ,S. S, 2016 . *Practical Zoology Invertebrate*, Rastogi Publications.
5	Verma, P. S. 2010. *A Manual of Practical Zoology*: Invertebates, S Chand, New Delhi
6	Lal S S, (2009). *Practical Zoology Vertebrate*, Rajpal and Sons Publishing

Reference Books
(Latest editions, and the style as given below must be strictly adhered to)

1	Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
2	Barnes, R.D. (1982). *Invertebrate Zoology,* V Edition. Holt Saunders International Edition.
3	Barrington, E.J.W. (1979). *Invertebrate Structure and Functions. II Edition,* E.L.B.S. and Nelson
4	Boradale, L.A. and Potts, E.A. (1961). *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
5	Lal, S.S. 2005. *A text Book of Practical Zoology*: Invertebrate, Rastogi, Meerut
Web Resources	
1	https://nbb.gov.in/
2	https://www.agshoney.com/training.htm
3	https://icar.org.in/
4	http://www.csrtimys.res.in/
5	http://csb.gov.in/
6	https://nisa.icar.gov.in/
7	https://www.nationalgeographic.com/animals/invertebrates/

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

ELECTIVE / GENERIC COURSE

Semester – II

ALLIED ZOOLOGY - II

Course Code **EC3**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	Allied Zoology - II	Core	Y	-	-	-	3	4	25	75	100
CO1	To enable students to learn basic concepts relating to aspects of respiratory, circulatory, excretory nervous and sensory physiology.										
CO2	To enable students to comprehend the processes involved during development.										
CO3	To enable students to learn basic concepts of immunity and the working of immune organs and familiarize them with the recommended vaccination schedule										
CO4	To enable students to comprehend the basic concepts of human genetics and patterns of inheritance										
CO5	To enable students to learn about aspects of animal behaviour such as foraging, courtship, nest construction, parental care and learning										

UNIT	**Details**	**No. of Hours**	**Course Objectives**
I	Respiration - Respiratory pigments and transport of gases. Mechanism of blood clotting. Types of excretory products – Ornithine cycle. Structure of neuron – Conduction of nerve impulse, Mechanism of vision and hearing.	12	CO1
II	Fertilization, Cleavage, Gastrulation and Organogenesis of Frog; Placentation in mammals	12	CO2
III	Immunity Innate and Acquired - Active and Passive; Antigens and Antibodies; Immunological organs – responses in humans; Vaccination schedule	12	CO3
IV	Human Genetics: Human Chromosomes – Sex Determination in Humans; Patterns of Inheritance: Autosomal Dominant, Autosomal Recessive, X-linked, Y-linked, Multiple Allelic and Polygenic; Genetic Counselling	12	CO4
V	Animal Behaviour: Foraging, Courtship Behaviour, Shelter and Nest Construction, Parental Care, Learning Behaviour	12	CO5
	Total	**60**	

Course Outcomes		
Course Outcomes	On completion of this course, students will	
CO1	Recall the parts and working of body organs and developmental stages, name the patterns of inheritance and list different types of animal behaviour.	PO1
CO2	Analyse the different developmental stages.	PO1, PO2
CO3	Analyse the working of body and immune systems.	PO4, PO6
CO4	Analyse the different patterns of inheritance.	PO4, PO5, PO6

CO5	Relate the behaviour of animals to physiology. Analyse the different types of behaviour	PO3, PO8
Text Books (Latest Editions)		
1	Verma P.S. & Agarwal – (1997), *Developmental Biology*, Chordata embryology S. Chand & Co.	
2	Michael D. Breed and Janice Moore, (2012), *Animal Behaviour,* Academic Press, USA,	
Reference Books (Latest editions, and the style as given below must be strictly adhered to)		
1	Owen, J. A., Punt, J. & Stranford, S. A. (2018), *Kuby Immunology*, New York: W.H. Freeman & Company	
2	Klug, W. S., Cummings, M. R. & Spencer, C (2016), *Concepts of Genetics*. (12th ed.). New Jersey: Pearson Education	
3	Mathur, R. (2014), *Animal Behaviour*. Meerut: Rastogi.	
4	David McFarland, (1985), *Animal Behaviour*, Longman Scientific & Technical, UK.	
5	Harjindra Singh, (1990), *A Text Book of Animal Behaviour*, Anomol Publication	

Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	25 Marks
	Assignments	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	75 Marks
	Total	**100 Marks**

Methods of Assessment	
Recall (K1)	Simple definitions, MCQ, Recall steps, Concept definitions
Understand/ Comprehend (K2)	MCQ, True/False, Short essays, Concept explanations, short summary or overview
Application (K3)	Suggest idea/concept with examples, suggest formulae, Solve problems, Observe, Explain
Analyse (K4)	Problem-solving questions, finish a procedure in many steps, Differentiate between various ideas, Map knowledge
Evaluate (K5)	Longer essay/ Evaluation essay, Critique or justify with pros and cons
Create (K6)	Check knowledge in specific or offbeat situations, Discussion, Debating or Presentations

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER – II

ALLIED ZOOLOGY LAB COURSE - II

Course Code **EC4**	Course Name	Category	L	T	P	S	Credits	Inst. Hours	Marks		
									CIA	External	Total
	ALLIED ZOOLOGY LAB COURSE - II	Core	-	-	Y	-	2	2	50	50	100

Learning Objectives	
CO1	To understand the vital physiological functions of our body like respiration and circulation.
CO2	To identify and compare the embryological developmental stages in frog
CO3	To understand the different immune system and its components of our body and gain knowledge about immunization schedule.
CO4	To compare the basic concept of genetic inheritance
CO5	To analyse the different pattern of behaviour and its physiology

UNIT	**Details**		**Course Objectives**
I	1. Examination and analysis of Ammonia. Urea and Uric acid 2. Estimation of haemoglobin using haemometer		CO1
II	**Observation of models, charts and diagrams**: Human heart, haemoglobin, neuron, eye, Snellen chart for vision test and ear, Human karyotype, Haemophilia, Colour Blindness, Hypertrichosis, Down's syndrome, Turner's syndrome, Klinefelters's syndrome;		CO4
III	**SPOTTERS-** Slides and Specimen Frog: egg, Cleavage, blastula, gastrula- yolk plug stage; any two placenta		CO2, CO3
IV	1. Examination of blood group- Demonstration 2. Immunization schedule by WHO		CO5
V	Record / Observation Note (SUBMISSION IS MANDATORY)		CO4, CO5

Course Outcomes		
Course outcomes	On Completion of this course, students will;	
CO1	Compare the different types of excretory products and patterns of excretion.	PO1, PO2, PO5
CO2	Examine the role of haemoglobin and Analyse the function of the heart, neurons and sense organs	PO1, PO3, PO5
CO3	Identify and examine the developmental stages and their	PO4, PO8

	significance.	
CO4	Comprehend the role of genes and the pattern of inheritance	PO6, PO8
CO5	Understand and apply the theoretical knowledge about immunization and behavioural types in daily life.	PO1, PO3, PO8
Text Books (Latest Editions)		
1	Verma P.S. & Agarwal (2004), *Developmental Biology, Chordata embryology,* S. Chand & Co.	
2	Widmaier, E.P., Raff, H. and Strang, K.T. (2008), *Vander's Human Physiology*, XI Edition., McGraw Hill., 770 PP	
3	Abhijit Dutta, (2009), *Experimental biology: A Laboratory Science*, Narosa, New Delhi.	
4	Roitt, M, Peter J. Delves, Seamus J. Martin And Dennis R. Burton, (2017), *Essential Immunology,* 13th Edition, Wiley-Blackwell Publishing,Usa,	
Reference Books (Latest editions, and the style as given below must be strictly adhered to)		
1	Owen, J. A., Punt, J. & Stranford, S. A. (2018), *Kuby Immunology*, New York: W.H. Freeman & Company	
2	Klug, W. S., Cummings, M. R. & Spencer, C (2016), *Concepts of Genetics*. (12th ed.). New Jersey: Pearson Education	
3	Mathur, R. (2014), *Animal Behaviour*. Meerut: Rastogi.	
Methods of Evaluation		
Internal Evaluation	Continuous Internal Assessment Test	50 Marks
	Dissection – Major and Minor	
	Mounting	
	Record Work	
	Attendance and Class Participation	
External Evaluation	End Semester Examination	50 Marks
	Total	**100 Marks**

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

MSU/2023-24/UG-Colleges/Part-III (Industrial Fish and Fisheries –Elective/ Generic)

SEMESTER I

(Elective/ Generic Course for I Year B.Sc Zoology Programme
Students from the Year 2023– 2024 onwards)

ELECTIVE/ GENERIC COURSE 1.1- BIOLOGY OF FISH

LEARNING OBJECTIVES (LOs)

The objectives are to enable the students to

- understand the basic concepts, types and problems of capture fisheries
- analyse the different techniques of capturing methods
- analyse the different techniques of capturing methods
- identify and compare the cultivable fish species and benefits
- apply the knowledge of fish marketing,

COURSE OUTCOMES (COs):

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

CO1: recollect the basic concepts of fisheries and recognize and solve the problems in capture fisheries

CO2: understand and adopt suitable/ recent technology for capturing

CO3: Apply knowledge on feeding patterns and design local strategies for management

CO4: evaluate and adopt suitable marketing methods and overcome the problems

CO5: emphasize the application of laws and acts of Fisheries welfare.

UNIT I

Introduction: Fish Biology – Definition and basic concepts of biosystematics. Importance of classification – Theories of biological classification. Variations in structure, Form, Skin, Coloration, Scales, Mouth, Jaws, Teeth, Fins, Spines and other structures used in taxonomic studies. Induced breeding techniques – Hatching methods – Seed and Brood transport.
(12L)

UNIT II

Study of external morphology and internal organization of a typical Elasmobranch and Teleost. Alimentary Canal and Associated Structures – Gills – Swim Bladder – AccessoryRespiratory organs – Lateral line system – Sound and Light producing organs. Morphological and anatomical characters of Prawn, Crab, Lobster, Bivalve, Gastropod and Cephalopod (one example each)
(12L)

UNIT III

Natural food of fishes – Feeding habits in various groups of fresh water and marine fishes, Prawns, Crabs, Lobsters and Cephalopods. Qualitative and Quantitative estimation of food consumption based on experimental studies and stomach content analysis – Seasonal changes in food availability and food preference – Food and Feeding in relation to age – Food selectively – Feeding intensity. Nutrition of fishes and utilization of food,Feeding strategies and energies. Artificial feeding – Nutritional requirement.
(12L)

UNIT IV

Growth of fish – Absolute, Relative, Isometric and Allometric growth. The Cube Law – Methods for determination of growth – Length frequency analysis – Analysis of growth checks on hard parts like Scales, Otolith and Vertebrae – Estimation of growth by direct methods – Marking and tagging of fish for growth studies – Aging of fish and shell-fish based on length data and growth checks – Length weight relationships, Ponderal index, Relative condition factor and Gonado – Stomach index.
(12L)

UNIT V

Types of reproduction, Sex differences – Sexual maturity, Classification of maturity stages, Size at first maturity. Estimation of fecundity – Ova diameter frequency – Fecundity in relation to length, Weight, Age and food supply. Spawning habits – Factors affecting Spawning, Spawning seasons and frequency. Embryonic and early development – Types of egg and Larvae – Metamorphosis of larva – Larval life and feeding habits. Reproductive behaviour and parental care – Social behaviour – Aggregation and Shoaling. Migrations – Anadromous and Catadromous. (12L)
(TOTAL 60L)

BOOKS FOR REFERENCE

1. Kyle, H. M., (1926), *The Biology of Fishes*, T.F.H. Publication, Hong Kong.
2. Marshell, N.B. (1965), *The Life of Fishes*, Weidenfeld& Nicolson, London.
3. Munro I.S.R, (1982), *The Marine and Freshwater Fishes of Ceylon*, Soni Reprints Agency, New Delhi.
4. Talwar, P.K. and A.G. Jhingran, (1991), *Inland Fishes of India and Adjacent Countries.,* Vol I & Vol II, Oxford & IBH Publishing Co. Ltd., New Delhi 1958 P.
5. Pitcher, T.J. & P.J.E. Hart, (1992), *Fisheries Ecology*, Room Helm, London.
6. Royce, W.F. (1984), *Introduction to the Practice of Fisheries Science*, Academic Press.
7. Rounsfell, G.A. and W.H. Everheart, (1993), *Fisheries Science its methods and application*, John William & Sons New York.

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

SEMESTER I – Lab on Elective /Generic Course

LAB ON ELECTIVE / GENERIC COURSE I- BIOLOGY OF FISH

L	T	P	C
…	…	2	3

PRACTICALS

1. Methods for Collection, Handling, Identification and Preservation of fish for taxonomic purposes.
2. Study of the external morphology of fish. Specific identification of important freshwater and marine fishes, prawns, crabs, bivalves and cephalopods of India.
3. Identification of scales of fishes – Placoid, Cycloid and Ctenoid scales.
4. Study of food and feeding habits of fishes – Plankton feeder, Herbivore feeder, Carnivore feeder, Omnivore feeder, and Detritus feeder. Study of Structural Adaptations for Diet.
5. Qualitative and Quantitative methods for Stomach content analysis.
6. Estimation of Oxygen, Carbon dioxide, and Salinity content in water samples.
7. Plankton analysis in the water samples – any two.
8. Identification of Anadromous and Catadromous fishes.

Books for reference

1. Kyle, H. M., (1926), *The Biology of Fishes*, T.F.H. Publication, Hong Kong.
2. Marshell, N.B. (1965), *The Life of Fishes*, Weidenfeld& Nicolson, London.
3. Munro I.S.R, (1982), *The Marine and Freshwater Fishes of Ceylon*, Soni Reprints Agency, New Delhi.
4. Talwar, P.K. and A.G. Jhingran, (1991), *Inland Fishes of India and Adjacent Countries.,* Vol I & Vol II, Oxford & IBH Publishing Co. Ltd., New Delhi 1958 P.
5. Pitcher, T.J. & P.J.E. Hart, (1992), *Fisheries Ecology*, Room Helm, London.
6. Royce, W.F. (1984), *Introduction to the Practice of Fisheries Science*, Academic Press.
7. Rounsfell, G.A. and W.H. Everheart, (1993), *Fisheries Science its methods and application*, John William & Sons New York.

MSU/2023-24/UG-Colleges/Part-III (Industrial Fish and Fisheries –Elective/ Generic)

SEMESTER II

ELECTIVE/ GENERIC COURSE II -CAPTURE FISHERIES

L	T	P	C
4	…	…	3

LEARNING OBJECTIVES (LOs)

The objectives are to enable the students to

- understand the basic concepts, types and problems of capture fisheries
- analyse the different techniques of capturing methods
- analyse the different techniques of capturing methods
- identify and compare the cultivable fish species and benefits
- apply the knowledge of fish marketing,

COURSE OUTCOMES (COs):

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

CO1: recollect the basic concepts of fisheries and recognize and solve the problems in capture fisheries

CO2: understand and adopt suitable/ recent technology for capturing

CO3: Apply knowledge on feeding patterns and design local strategies for management

CO4: evaluate and adopt suitable marketing methods and overcome the problems

CO5: emphasize the application of laws and acts of Fisheries welfare.

UNIT I

Capture Fisheries – Inland Capture Fisheries – Scope and importance of Capture Fisheries in India and World. Present yield and Estimates of Potential. Inland capture fishery resources of Indian Fisheries of major and minor carps. Cat fishes and other groups. Problems and management.

(12L)

UNIT II

Cold water fishery resources – Fisheries of trout, Mahaseer and other Coldwater Species. Lacustrine fisheries – Species, Catch, Fishing gears, Potential and Problems of Development and management. Estuarine fisheries. Fisheries of Brackish water lakes and backwaters – Problems and Management.

(12L)

UNIT III

Salient features of cultivable species of fishes and shellfishes. Marine fishery resources of India – Fisheries of Sardine, Lesser Sardine, Anchovies, Other Clupeoids, Mackerel, Ribbon fishes, Tunnies, Carangids and Cephalopods.

(12L)

UNIT IV

Mid water and Demersal fisheries – Fisheries of Elasmobranches, Bombay duck, Cat fishes, Silver Bellies, Sciaenids, Pomfrets, Threadfins, Thread fin breams and Perches, Flatfishes, Prawns, lobsters, Crabs, Mussels Oysters and Clams, Culture of edible Oyster.

(12L)

UNIT V

Biological aspects of fishery management, Principles of Conservation, Development and Management Concepts and practice. Population dynamics – Concept of recruitment and yield, problems of overfishing, MSY, MEY and OSY

(12L)

(TOTAL 60L)

Mapping with Programme Outcomes:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	S							
CO2	M	S						
CO3				S		S		
CO4				S	S	M		
CO5			S					S

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

MSU/2023-24/UG-Colleges/Part-III (Industrial Fish and Fisheries –Elective/ Generic

SEMESTER -II / Lab on Allied/ Generic Course

LAB ON ELECTIVE/ GENERIC COURSE II- CAPTURE FISHERIES

L	T	P	C
…	…	2	3

1. Identification of commercial freshwater and marine prawns.
2. Visit to a Prawn farm.
3. Visit to the fish processing industry.
4. Visit to a Landing center.
5. Raceway culture system.