University of Kerala

Four Year Under Graduate Programme (UoK FYUGP)

Syllabus

Major Discipline Zoology

May 2024

About the Discipline

Zoology, as a discipline, serves as the cornerstone of understanding the vast diversity of animal life on Earth. It encompasses the study of animals, ranging from microscopic organisms to complex multicellular organisms, including their behavior, physiology, ecology, evolution, and conservation. Undergraduate and postgraduate programs in Zoology offer students a comprehensive education in biological sciences, with a particular focus on the animal kingdom.

The scope of Zoology is extensive, as it provides insights into various aspects of animal life, including their structure, function, interactions with the environment, and evolutionary history. It allows students to explore the fascinating world of animals, from their anatomical adaptations to their ecological roles within ecosystems. Moreover, Zoology plays a crucial role in addressing pressing global challenges, such as biodiversity loss, habitat destruction, and emerging infectious diseases, by providing scientific knowledge necessary for conservation efforts and wildlife management. Understanding animal life is crucial for various reasons:

Biodiversity Conservation: Zoologists play a vital role in understanding, conserving, and managing biodiversity. By studying animal behavior, ecology, and population dynamics, they contribute to conservation efforts aimed at protecting endangered species and preserving ecosystems.

Medicine and Health: Many breakthroughs in medicine have been inspired by animal research. Zoologists study animal physiology and genetics, contributing to advancements in areas like pharmacology, disease research, and biotechnology.

Ecology and Environmental Science: Zoology provides insights into the interactions between organisms and their environment. This knowledge is crucial for addressing pressing environmental issues such as climate change, habitat destruction, and pollution.

Agriculture and Food Security: Understanding animal behavior, physiology, and genetics is essential for improving livestock production and developing sustainable agricultural practices to ensure food security for a growing global population. One of the key strengths of Zoology lies in its interdisciplinary nature, as it integrates principles from biology, ecology, genetics, physiology, and evolution to understand the complexities of animal life. Specializations within Zoology can include fields such as ethology (the study of animal behavior), marine biology, entomology (the study of insects), ornithology (the study of birds), herpetology (the study of amphibians and reptiles), and many others. These specialties allow students to delve deeper into specific areas of interest and develop expertise in particular taxa or research methodologies.

Career prospects for graduates with a degree in Zoology are diverse and rewarding. Graduates can pursue careers in academia, research institutions, government agencies, zoos, museums, conservation organizations, pharmaceutical companies, environmental consulting firms, and more. They may work as researchers, wildlife biologists, conservation biologists, environmental educators, zookeepers, veterinarians, or science communicators. Additionally, Zoology provides a solid foundation for further studies in related fields such as ecology, evolutionary biology, animal behavior, genetics, or conservation biology.

In terms of research prospects, Zoology offers abundant opportunities for groundbreaking discoveries and contributions to scientific knowledge. Research in Zoology spans a wide range of topics, from fundamental studies on animal physiology and behavior to applied research aimed at addressing real-world conservation challenges. Advances in technologies such as genomics, bioinformatics, remote sensing, and imaging techniques continue to revolutionize the field, opening up new avenues for research and exploration. As such, Zoology remains a dynamic and vibrant discipline that continues to inspire curiosity and drive innovation in our understanding of the natural world.

In conclusion, Zoology is a dynamic and interdisciplinary field with immense scope and relevance in today's world. From unravelling the mysteries of animal behavior to addressing pressing environmental challenges, zoologists contribute to our understanding of the natural world and play a crucial role in shaping our future. Whether pursuing a career in research, conservation, education, or industry, a degree in Zoology opens doors to a rewarding and impactful profession.

This syllabus is prepared by:

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Graduate Attributes

Graduate attributes bridge the gap between academia and the real world, fostering lifelong learning and meaningful contributions. They denote the skills, competencies and high-level qualities that a student should acquire during their university education. Apart from gathering content knowledge, these attributes go beyond the assimilation of information to its application in various contexts throughout a graduate's life. It aims in inculcating the art of critical thinking, problem solving, professionalism, leadership readiness, teamwork, communication skills and intellectual breadth of knowledge. The University of Kerala envisages to pave the path in guiding the student's journey to shape these attributes uniquely, making them integral to personal growth and success in various spheres of life. The University strives to ensure that these graduate attributes are not just checkboxes, but they play a pivotal role in shaping the students into capable, compassionate and responsible individuals with a high degree of social responsibility.

Programme Outcomes (PO)

No.	Programme Outcomes (POs)
PO-1	**Critical thinking** ○ analyze information objectively and make a reasoned judgment ○ draw reasonable conclusions from a set of information, and discriminate between useful and less useful details to solve problems or make decisions ○ identify logical flaws in the arguments of others ○ evaluate data, facts, observable phenomena, and research findings to draw valid and relevant results that are domain-specific
PO-2	**Complex problem-solving** ○ solve different kinds of problems in familiar and no-familiar contexts and apply the learning to real-life situations ○ analyze a problem, generate and implement a solution and to assess the success of the plan ○ understand how the solution will affect both the people involved and the surrounding environment
PO-3	**Creativity** ○ produce or develop original work, theories and techniques ○ think in multiple ways for making connections between seemingly unrelated concepts or phenomena ○ add a unique perspective or improve existing ideas or solutions ○ generate, develop and express original ideas that are useful or have values
PO-4	**Communication skills** ○ convey or share ideas or feelings effectively ○ use words in delivering the intended message with utmost clarity ○ engage the audience effectively

	○ be a good listener who are able to understand, respond and empathize with the speaker ○ confidently share views and express himself/herself
PO-5	**Leadership qualities** ○ work effectively and lead respectfully with diverse teams ○ build a team working towards a common goal ○ motivate a group of people and make them achieve the best possible solution. ○ help and support others in their difficult times to tide over the adverse situations with courage
PO-6	**Learning 'how to learn' skills** ○ acquire new knowledge and skills, including 'learning how to learn skills, that are necessary for pursuing learning activities throughout life, through self-paced and self-directed learning ○ work independently, identify appropriate resources required for further learning ○ acquire organizational skills and time management to set self-defined goals and targets with timelines ○ inculcate a healthy attitude to be a lifelong learner
PO-7	**Digital and technological skills** ○ use ICT in a variety of learning and work situations, access, evaluate, and use a variety of relevant information sources ○ use appropriate software for analysis of data ○ understand the pitfalls in the digital world and keep safe from them
PO-8	**Value inculcation** ○ embrace and practice constitutional, humanistic, ethical, and moral values in life including universal human values of truth, righteous conduct, peace, love, nonviolence, scientific temper, citizenship values ○ formulate a position/argument about an ethical issue from multiple perspectives ○ identify ethical issues related to work, and follow ethical practices, including avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data, or committing plagiarism, and adhering to intellectual property rights ○ adopt an objective, unbiased, and truthful actions in all aspects of work

Programme Specific Outcomes (PSO)

No.	Upon completion of the Undergraduate programme in Zoology the graduate will be able to	PO No.
PSO-1	Demonstrate Proficiency in Zoological Concepts and Principles, Understand and apply fundamental concepts in zoology including taxonomy, anatomy, physiology, ecology, and evolution.	PO1, PO2
PSO-2	Collect, analyze, and interpret data related to animal behavior, population dynamics, and ecological interactions using appropriate statistical and computational methods. Present research findings, theories, and concepts in zoology effectively through written reports, oral presentations, and visual aids to diverse audiences. Communicate scientific information effectively	PO1, PO3, PO4, PO5, PO6, PO7
PSO-3	Explore the diversity of animal life across different taxonomic groups and understand the physiological, morphological, and behavioral adaptations that enable their survival in various environments. Evaluate the impact of human activities on wildlife.	PO1, PO2, PO3, PO4, PO6, PO7, PO8
PSO-4	Demonstrate, explain and appreciate the molecular and cellular basis of physiological functions in animals and dynamics of life system.	PO7, PO8
PSO-5	Acquire innovative skills which will enable production of knowledge and skills required for employment in biochemistry, Fisheries Science /Entomology/ Environmental Science, microbiology, aquaculture, vermiculture/apiculture and bio technology on the level of the gene, genome, and their functions.	PO5, PO6, PO8
PSO-6	Perform practical skills in the areas of laboratory experiments and good laboratory practices (GLP) related to dissection, developmental biology, biochemistry, cell and molecular biology, genetics, immunology and microbiology.	PO6. PO8
PSO-7	Work collaboratively with professionals from diverse disciplines such as ecology, genetics, conservation biology, and environmental science to address complex issues related to animal biology and conservation.	PO5, PO6, PO8

COURSE CODE AND TITLES

Semester	Course Type	Course Code	Course Title
Semester I	**DSC**	UK1DSCZOO101	Non-Chordate Diversity - Part I
		UK1DSCZOO102	Diversity of Non-chordates
		UK1DSCZOO103	Wildlife Biology and Conservation
		UK1DSCZOO104	Human Nervous System and Behaviour
	MDC	UK1MDCZOO101	Health and Sex education
Semester II	**DSC**	UK2DSCZOO101	Non-Chordate Diversity - Part II
		UK2DSCZOO102	Wildlife Ecology
		UK2DSCZOO103	Aquatic Ecosystems and Sustainable Management
		UK2DSCZOO104	Sensory Physiology
	MDC	UK2MDCZOO101	Global Climate Change
Semester III	**DSC**	UK3DSCZOO201	Chordate Diversity - Part I
		UK3DSCZOO202	Diversity of Chordates
		UK3DSCZOO203	Concepts of Ethology
		UK3DSCZOO204	Body functions and Regulation
		UK3DSCZOO205	Human Parasitology and Vector-borne Diseases
	DSE	UK3DSEZOO201	Fisheries Science I- Taxonomy and Fishery Biology
		UK3DSEZOO202	Entomology I -General Entomology
		UK3DSEZOO203	Environmental Science I- Global Environmental Issues
	MDC(KS)		
	VAC	UK3VACZOO201	Nutrition, Health and Wellness
Semester IV	**DSC**	UK4DSCZOO201	Chordate Diversity-Part II
		UK4DSCZOO202	Evolution and Zoogeography
		UK4DSCZOO203	Comparative Anatomy of Vertebrates
	DSE	UK4DSEZOO201	Fisheries Science II- Principles of Aquaculture
		UK4DSEZOO202	Entomology II- Industrial Entomology
		UK4DSEZOO203	Environmental Science II- Environmental Pollution
	VAC	UK4VACZOO201	Communication and Popularisation of Life Sciences
		UK4VACZOO202	Bioeconomics and Ecotourism
	SEC	UK4SECZOO201	Livestock Management
	Internship	UK4INTZOO200	Internship in Zoology
Semester V	**DSC**	UK5DSCZOO301	Developmental Biology
		UK5DSCZOO302	Animal Physiology
		UK5DSCZOO303	Microbiology and Immunology
		UK5DSCZOO304	Agrochemicals and Agricultural Pest Management
	DSE	UK5DSEZOO301	Ecology and Disaster Management
		UK5DSEZOO302	Fisheries Science III- Culture of Finfishes and Shellfishes

		UK5DSEZOO303	Entomology III- Medical and Veterinary Entomology
		UK5DSEZOO304	Environmental Science III- Environmental Monitoring and Ecosystem Restoration
	SEC	UK5SECZOO301	Vermiculture and Vermicomposting
Semester VI	**DSC**	UK6DSCZOO301	Cell and Molecular Biology
		UK6DSCZOO302	Genetics and Biotechnology
		UK6DSCZOO303	Biochemistry
		UK6DSCZOO304	Nanobiology
	DSE	UK6DSEZOO301	Animal Behaviour and Chronobiology
		UK6DSEZOO302	Fisheries Science IV- Fish Processing Technologies
		UK6DSEZOO303	Entomology IV- Forensic Entomology
		UK6DSEZOO304	Environmental Science IV- Green Technologies
	SEC	UK6SECZOO301	Ornamental Fish Production and Aquarium Management
Semester VII	**DSC**	UK7DSCZOO401	Instrumentation and Biological Techniques
		UK7DSCZOO402	Omics and Bioinformatics
		UK7DSCZOO403	Systematics and Phylogenetics
		UK7DSCZOO404	Human Physiology: The Life Sustaining systems
	DSE	UK7DSEZOO401	Research Methodology and Biostatistics
Semester VIII	**DSC-Online/DL**		
	Project	UK8CIPZOO400 OR UK8RPHZOO400	Capstone Internship Project in Honours Programme OR Project in Honours with Research Programme

Note: To obtain an undergraduate degree with Zoology major, it is mandatory that a student must study and pass the following courses from the course baskets.

1. UK1DSCZOO101 Non-Chordate Diversity -Part I
   Or
   UK1DSCZOO102 Diversity of Non-Chordates

2. UK2DSCZOO101Non Chordate Diversity -Part II
   Or
   UK1DSCZOO102 Diversity of Non-Chordates

3. UK3DSCZOO201 Chordate Diversity-Part I
   Or
   UK3DSCZOO102 Diversity of Chordates

4. UK4DSCZOO201 Chordate Diversity-Part II
5. UK4DSCZOO202 Evolution and Zoogeography
6. UK5DSCZOO301 Developmental Biology
7. UK5DSCZOO302 Animal physiology
8. UK5DSEZOO301 Ecology and Disaster Management
9. UK6DSCZOO301 Cell and Molecular Biology

10. UK6DSCZOO302 Genetics and Biotechnology
11. UK6DSEZOO301 Animal Behaviour and Chronobiology

Note: To obtain an undergraduate honours degree with Zoology major, it is mandatory that a student must study and pass additionally the course listed below from the course baskets.

12. UK7DSEZOO401 Research Methodology and Biostatistics

Note: The following bunch of courses shall form a specialisation in the Zoology Discipline if the student may study and pass as his/her Discipline Specific Elective (DSE) during the specified duration of the course of study in the undergraduate programme in Zoology.

1. Zoology major with specialisation in Fisheries Science

UK3DSEZOO201 Fisheries Science I- Taxonomy and Fishery Biology
UK4DSEZOO201 Fisheries Science II- Principles of Aquaculture
UK5DSEZOO302 Fisheries Science III- Culture of Finfishes and Shellfishes
UK6DSEZOO302 Fisheries Science IV- Fish Processing Technologies

2. Zoology major with specialisation in Entomology

UK3DSEZOO202 Entomology I -General Entomology
UK4DSEZOO202 Entomology II- Industrial Entomology
UK5DSEZOO303 Entomology III- Medical and Veterinary Entomology
UK6DSEZOO303 Entomology IV- Forensic Entomology

3. Zoology major with specialisation in Environmental Science

UK3DSEZOO203 Environmental Science I- Global Environmental Issues
UK4DSEZOO203 Environmental Science II- Environmental Pollution
UK5DSEZOO304 Environmental Science III- Environmental Monitoring and Ecosystem Restoration
UK6DSEZOO304 Environmental Science IV- Green Technologies

Note: Each student (who is physically fit) must participate in the Study tour programme/Field study programme for not less than 5 days as specified in the syllabus preferably within the Kerala state. The programme can be conducted either as one/two-day programmes separately in semesters or as a single programme at the third year. The Study tour programme/Field study programme should include places of zoological importance (at least one Life science research institution/ Wildlife sanctuary/National Park/ Zoological Garden/ Museum etc). The institutions/authorities should ensure necessary assistance for the smooth conduct of the study tour/field study programmes. The Board of Studies recommend the University of Kerela to award extra academic credit(s) to the student if he /she has submitted a detailed report of the Study tour programme/Field study programme after participation.

SEMESTER I

	University of Kerala				
Discipline	**ZOOLOGY**				
Course Code	**UK1DSCZOO101**				
Course Title	**Non-Chordate Diversity - Part I**				
Type of Course	**DSC**				
Semester	I				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	0	2 hours	5
Pre-requisites	Pass in class XII				
Course Summary	This course provides the students with an in-depth knowledge of the diversity in form, structure and habits of acoelomata to pseudocoelomata. By the end of the course, the students shall get a comprehensive understanding of the diversity, biology, and ecological significance of invertebrate animals and the students shall achieve an appreciation for their crucial role in the natural world.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Introduction to Zoology**		**5**
	1.1	Taxonomy, nomenclature, principles of nomenclature, International Code of Zoological Nomenclature (ICZN), uni, bi and trinomialism	3
	1.2	Five kingdom classification, Three domain system, Super- group model of eukaryotes, tree of life approach in animal classification (Brief account)	2
II	**Protista, Parazoa and Metazoa**		**10**

	2.1	Levels of organization- cellular, tissue, organ and organ system. Radiata, Bilateria, Acoelomata, Pseudocoelomata, Eucoelomata, Protostomia, Deuterostomia.	2
	2.2	General characters of Protista, Parazoa and Metazoa	2
	2.3	Zoological importance and systematic position of Noctiluca, Paramecium and Trichonympha.	2
	2.4	Parasitic protozoans- Morphology, life cycle, pathogenicity and prophylaxis of *Plasmodium vivax* and *Trypanosoma gambiense.*	4
III	**Porifera**		**8**
	3.1	General Characteristics and classification (up to classes)	1
	3.2	Calcispongia: eg. Sycon; Hydrospongia: eg. Euplectella: Demospongia, eg. Spongilla.	4
	3.3	General topic: Canal system in sponges	3
IV	**Cnidaria and Ctenophora**		**9**
	4.1	General characteristics and classification (up to classes)	1
	4.2	Hydrozoa eg. Obelia, Physalia; Scyphozoa: eg. Aurelia; Anthozoa: eg. Sea anemone	3
	4.3	General topic: Polymorphism in Cnidarians; Corals - different types, Coral reefs	3
	4.4	General characteristics and Evolutionary significance of Ctenophora, Plurobranchia (Brief account).	2
V	**Platyhelminthes and Nemathelminthes**		**13**
	5.1	General characteristics and classification (up to classes) of Platyhelminthes	1
	5.2	Turbellaria: eg. Planaria, Trematoda: eg. Fasciola, Cestoda : eg. *Taenia solium*. General topic: Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*	7
	5.3	General characteristics of Nemathelminthes: *Caenorhabdites elegans* (Brief account), General topic: Human nematode parasites (*Ascaris*, *Enterobius*, *Ancylostoma*, *Wuchereria* and *Trichinella*)	5

References

1. Barnes, R.D. (1987): Invertebrate Zoology. W: B. Sunders. New Delhi.
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. (1967). Invertebrate Structure and Function. ELBS and Nelson, London.

4. Brusca, R.C, Giribet G, and Moore W (2023). Invertebrates (fourth edition). Sinauer Associates, Sunderland, M.A. Oxford University Press, USA.
5. Burki F, Roger AJ, Brown MW, Simpson AGB (January 2020). "The New Tree of Eukaryotes". Trends Ecol Evol. 35 (1): 43–55.
6. Dhami. P.S and Dhami, J. K. (1979). Invertebrate zoology. R. Chand & Co. New Delhi.
7. Ekambaranatha Ayyar M. (1990). A Manual of Zoology. Invertebrata- Part1 & PartII. S. Viswanathan Printers and Publishers. Pvt. Ltd.
8. International Edition.
9. Jordan, EL and Verma, P.S. (2000). Invertebrate Zoology. S. Chand and Co Ltd. New Delhi.
10. Kotpal, R.I, Agarwal, S.K. and R.P. Khetarpal. (2002). Modern text book of Zoology, Invertebrates.
11. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders
12. Whittaker, R.H. (1969). "New concepts of kingdoms or organisms. Evolutionary relations are better represented by new classifications than by the traditional two kingdoms". Science. 163 (3863): 150–60.
13. Woese CR, Kandler O, Wheelis ML (June 1990). "Towards a natural system of organisms: proposal for the domains Archaea, Bacteria, and Eucarya". Proceedings of the National Academy of Sciences of the United States of America. 87 (12): 4576–9

Web Resources

1. https://eol.org
2. http://www.tolweb.org
3. https://www.marinebio.org/creatures/marine-invertebrates
4. https://www.montereybayaquarium.org/animals/animals

Practicum (30 hrs)

Sl No.	Contents
1	Examination of pond water collected from different places for diversity in Protista
2	Demonstration of ciliary movement in Paramecium
3	Study of Sycon, Hyalonema, Euplectella, Spongilla
4	Study of Obelia, Physalia, Hydra, Millepora, Aurelia, Tubipora, Gorgonia, Pennatula, Fungia, Meandrina, Madrepora
5	Study of *Fasciola hepatica*, *Taenia solium* and their life cycles
6	Study of *Ascaris lumbricoides* and its life stages
7	Study of parasitic protists
8	Submit a report on invertebrate diversity after visiting a forest/marine/ freshwater/ wetland ecosystem

References

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. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
3. Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home
4. Brusca, R.C, Giribet G, and Moore W (2023). Invertebrates (fourth edition). Sinauer Associates, Sunderland, M.A. Oxford University Press, USA.
5. Dhami. P.S and Dhami, J. K. (1979). Invertebrate zoology. R. Chand & Co. New Delhi.
6. Ekambaranatha Ayyar M. (1990). A Manual of Zoology. Invertebrata- Part1 & PartII. S. Viswanathan Printers and Publishers. Pvt. Ltd.
7. Henry Sherring Pratt (2015). A Course in Invertebrate Zoology: A Guide to the Dissection and Comparative Study of Invertebrate Animals. Palala Press
8. Jordan, EL and Verma, P.S. (2000). Invertebrate Zoology. S. Chand and Co Ltd. New Delhi.
9. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics of taxonomy and new methods of classification	U	PSO-1,3
CO-2	Understand the diagnostic characters of different phyla through brief studies of examples.	R, U	PSO-1, 3
CO-3	Obtain an overview of polymorphic form, evolutionary significant and parasitic invertebrate especially acelomata to pseudocelomata	R, U	PSO-1, 4
CO-4	Apply identification skill, to observe and categorise organism	Ap	PSO-6
CO-5	Understand the faunal diversity of various ecosystems	Ap	PSO-6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Non-Chordate diversity - Part 1
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the basics of taxonomy and new methods of classification	PO2 PSO-1, 3	U	F	**L**	
CO-2	Understand the diagnostic characters of different phyla	PO-2, 3 PSO -1, 3	R, U	F,C	**L**	

	through brief studies of examples.					
CO-3	Obtain an overview of polymorphic form, evolutionary significant and parasitic invertebrate especially acoelomata to pseudocoelomata	PO6 PSO -1, 4	R, U	F,C	**L**	
CO-4	Apply field identification skill to categorise organism	PO6 PSO -6	Ap	F,C,P		**P**
CO-5	Understand the faunal diversity of various ecosystems	PO-2 PSO -6	Ap	F,C,P		**P**

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PSO 8**	**PO 1**	**PO2**	**PO 3**	**PO 4**	**PO5**	**PO 6**
CO 1	3	-	3	-	-	-	-	-	-	2	-	-	-	-
CO 2	3	-	2	-	-	-	-	-	-	2	2	-	-	-
CO 3	3	-	-	2	-	-	-	-	-	-	-	-	-	3
CO 4	-	-	-	-	-	3	-	-	-	-	-	-	-	2
CO 5	-	-	-	-	-	3	-	-	-	-	-	-	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics

1. Students shall collect any five invertebrates and add a brief note and then submit for evaluation
2. Invertebrates and human health
3. Parasitic adaptation of Nematodes
4. Polymorphism in Cnidarians
5. Life cycle of *Plasmodium vivax*

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Submission of activity report
4. Test
5. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer questions
4. Essay Type questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK1DSCZOO102**				
Course Title	**Diversity of Non- Chordates**				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in class XII				
Course Summary	This course offers students a comprehensive understanding of the varied forms, structures, and behaviours exhibited by invertebrate animals. Through exploration of the major groups of invertebrates, including arthropods, which dominate the planet's animal species, students gain insights into biodiversity. Moreover, the course equips the learners with the necessary tools to describe and appreciate biodiversity.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Protista and Animalia**	**8**
	1.1	**Introduction**: Classification of organisms- two kingdom system, three kingdom system, four kingdom system and five kingdom system.	2
	1.2	**Kingdom- Protista-** General features and classification: Examples- Noctiluca, Trichonympha and Paramecium Morphology, life history, pathogenicity and prophylaxis of *Plasmodium vivx*	3
	1.3	**Kingdom Animalia**: Salient features. Levels of organization- cellular, tissue, organ and organ system. Radiata, Bilateria, Acoelomata, Pseudocoelomata, Eucoelomata, Protostomia, Deuterostomia. Branches- Mesozoa, Parazoa and Eumetazoa. Body segmentation- metamerism and pseudo metamerism.	3
II		**Porifera, Cnidaria and Platyhelminthes**	**10**
	2.1	**Phylum Porifera**: General characters, Classification up to classes- Sycon, Euplectella, Spongilla	3

	2.2	**Phylum Cnidaria**: General characters, Classification up to classes. Examples - Obelia, Aurelia, Sea anemone and Physalia. Mention polymorphism and larval stages.	3
	2.3	**Phylum Platyhelminthes**: General characters, Classification up to classes- Examples - Bipalium, Fasciola and *Taenia solium* . (Life cycle of *Taenia solium*)	4
III		**Nemathelminthes and Annelida**	**6**
	3.1	**Phylum Nemathelminthes**: General characters, Ascaris and Trichinella. General Topic - Human nematode parasites (*Ascaris*, *Enterobius*, *Ancylostoma*, *Wuchereria* and *Trichinella*)	3
	3.2	**Phylum Annelida**: General characters, Hirudinaria, Nereis (mention parapodium, heteronereis.) and Earthworm (mention setae;vermiculture)	3
IV		**Arthropoda and Mollusca**	**14**
	4.1	**Phylum Arthropoda**: General characters, Prawn (Morphology, Nervous system, Larval stages), Cockroach (external characters, mouth parts, digestive system); Limulus, Scorpion, Sacculina and Spirostreptus Mosquitoes - Anopheles, Culex and Aedes and pathogenicity of mosquitoes.	8
	4.2	**Phylum Mollusca**: General characters, Pearl oyster, Pila and Sepia General topic: Economic importance of mollusca	6
V		**Onychophora and Echinodermata**	**7**
	5.1	**Phylum Onychophora**: General characters, eg. Peripatus- evolutionary significance.	2
	5.2	**Phylum Echinodermata**: General characters, Star fish, Sea urchin and Sea cucumber. Mention larval stages.	5

References

1. Barnes, R.D. (1987). Invertebrate Zoology. W: B. Sunders. New Delhi.
2. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). The
3. Ekambaranatha Ayyar M. (1990). A Manual of Zoology. Vol. Invertebrata- Part1 &
    a. Invertebrates: A New Synthesis, III Edition, Blackwell Science
4. Jordan, EL and Verma, P.S. (2000). Invertebrate Zoology. S. Chand and Co Ltd. New Delhi
5. Kotpal, R. L. (2005). Modern text book of Zoology Invertebrates (Animal Diversity-I). Rastogi Publications pp 795-831.
    a. Part II. S. Viswanathan Printers and Publishers. Pvt. Ltd.
6. Rastogi V. B. (2015). Invertebrate Zoology. Publisher- Kedar Nath Ram Nath.

Practicum (30 hrs)

Sl No.	Contents
1	Protista: Noctiluca, Paramecium, Entamoeba (spotters)
2	Porifera: Sycon (spotters)
3	Cnidaria: Obelia, Physalia, Sea anemone(spotters)
4	Platyhelminthes: Fasciola, *Taenia solium* (spotters)
5	Nematoda: Ascaris, Ancylostoma (spotters)
6	Annelida: Nereis, Hirudinaria(spotters)
7	Arthropoda: Limulus, Scorpion, Sacculina (spotters)
8	Mollusca: Pearl Oyster, Sepia (spotters)
9	Echinodermata: Starfish, Sea urchin, Sea cucumber(spotters)
10	Examination of pond water collected from different places for diversity in protists
11	Submit a report on 5 invertebrate animals from various phyla after visiting Campus/Ecosystem
12	Mount the mouth parts of Cockroach / Honey bee/ mosquito (any one)
13	Mounting of Earthworm setae/ Nereis parapodium
14	Dissection of nervous system of prawn/ Digestive system of Cockroach (any one)

References

1. Verma, P. S. (2015). A Manual of Practical Zoology Invertebrates. S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110055.
2. Yadav, V., Yadav, P. Varshney, V. K., Varshney, V. C. (2015). Text Book of Practical Zoology-I. Publisher- Kedar Nath Ram Nath Meerut.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics of taxonomy and new methods of classification.	U	PSO-1,3
CO-2	Understand the diagnostic characters of different phyla through examples.	R, U	PSO-1, 3

CO-3	Obtain an overview of general characters of Nemathelminthes and their parasitic adaptation	R, U	PSO-1, 3
CO-4	Develop skill to identify and categorise organism	Ap	PSO-6
CO-5	Gain knowledge about the life cycle of human parasites	R, U, Ap	PSO- 1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Diversity of Non-Chordates

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
CO-1	Understand the basics of taxonomy and new methods of classification	PO - 1,2,3,4 PSO-1, 3	U	F	L	
CO-2	Understand the diagnostic characters of different phyla through brief studies of examples.	PO - 1,2,3,4 PSO-1, 3	R, U	F, C	L	
CO-3	To obtain an overview of general characters of Nemathelminthes and their parasitic Adaptation	PO - 1,2,3,4 PSO-1, 3	R, U	E, C	L	
CO-4	Apply field identification skill to categorise organism	PO - 1,2 PSO- 1,6	Ap	F, C, P		P
CO-5	Gain Knowledge	PO - 2,3,4	U, Ap	F, C	L	

	about the life history of human parasites	PSO -1,2				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	-	2	-	-	-	-	3	2	2	3	-	-	-	-
CO 2	3	-	2	-	-	-	-	2	1	2	3	-	-	-	-
CO 3	3	-	3	-	-	-	-	3	3	2	3	-	-	-	-
CO 4	2	-	3	-	-	3	-	2	3	-	-	-	-	-	2
CO 5	2	2	-	-	-	-	-	-	3	2	2	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics

1. Human Nematode parasites

2. Economic importance of molluscs
3. Different types and pathogenicity of mosquitoes.
4. Life cycle of *Taenia solium*
5. Peripatus and its evolutionary significance

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Test
4. Model preparation

End Semester evaluation

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Essay type questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK1DSCZOO103**				
Course Title	**Wildlife Biology and Conservation**				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3	-	2	5
Pre-requisites	Pass in class XII				
Course Summary	This course provides a foundational understanding of wildlife biology and conservation principles. It covers various aspects of wildlife biology including wildlife habitats, threats to wildlife, conservation strategies and wildlife monitoring and research. Through lectures, discussions, practicals and fieldwork, students will gain insights into the diversity of wildlife species, their habitats, threats, and conservation efforts.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Introduction to Wildlife Biology**		**3**
	1.1	Definition of Wildlife, Values of Wildlife	2
	1.2	Need of Wildlife Conservation	1
II	**Wildlife Habitats**		**8**
	2.1	Wildlife habitats - Forest Habitat (eg: Shola forest of Western Ghat); Desert Habitat (eg: Thar Desert); Aquatic habitat (eg: Vembanad lake); Wetland habitat (eg: Sunderbans delta); Mangrove habitat (eg: Pichavaram mangrove forest). Mention Biodiversity Hotspots in India.	6
	2.2	Ecological significance of Keystone species, Edge species and Umbrella species	2
III	**Wildlife Conservation Strategies**		**16**

	3.1	*In-situ* conservation -National Parks, Biosphere reserves, Wildlife Sanctuaries, Mangrove forests with examples in India and Kerala (Brief description)	7
	3.2	*Ex-situ* conservation- Zoological Parks with examples in India and Kerala, Captive breeding (Brief description with examples)	4
	3.3	IUCN Red Data Book	1
	3.4	Project Tiger, Project Elephant, Project Cheetah, Project Rhino and Project Crocodile (brief account)	2
	3.5	Wildlife conservation organizations, agencies and schemes - WWF, Nagar Van Yojana (NVY), BNHS, Wildlife Conservation Society(WCS), IUCN, ASEAN-WEN	1
	3.6	Indian Wildlife (Protection) Act, 1972; Biological Diversity Act of 2002 (brief account)	1
IV	**Threats to Wildlife**		**9**
	4.1	Major threats to Wildlife: Habitat loss and fragmentation, Over exploitation, Climate change, Poaching, Pollution	4
	4.2	Invasive species. (Eg.-Apple Snail (*Pomacea canaliculata*)	2
	4.3	Man-animal conflict and its management	3
V	**Wildlife Monitoring and Research**		**9**
	5.1	Wildlife monitoring (Brief account) –- Direct count (Block count, Transect methods, Point counts, Visual encounter survey, Waterhole survey), Indirect count (Call count, track and signs, pellet count, pugmark, camera trap, M-stripe).	7
	5.2	Wildlife Research Institutes- KFRI, KSBB, IIFM, Salim Ali Centre for Ornithology and Natural History (SACON).	2

References:

1. Begon, M., Townsend, C. R., & Harper, J. L. (2006). Ecology: From Individuals to Ecosystems (4th ed.). Wiley-Blackwell.
2. Groom, M. J., Meffe, G. K., & Carroll, C. R. (2006). Principles of Conservation Biology (3rd ed.). Sinauer Associates.
3. Hunter M.L., Gibbs, J.B. and Sterling, E.J. (2008). Problem-Solving in Conservation
4. Pullin, A. S., & Knight, T. M. (Eds.). (2009). Conservation Biology (1st ed.). Cambridge University Press.
5. Soule, M. E., & Orians, G. H. (Eds.). (2001). Conservation Biology: Research Priorities for the Next Decade. Island Press.
6. Sutherland, W. J. (Ed.). (2001). Conservation Science and Action. Blackwell Science.
7. Wildlife Protection Act (1972). Natraj Publ.Co. Dehradun
8. Woodroffe R., Thirgood, S. and Rabinowitz, A. (2005). People and Wildlife, Conflict or Co-existence? Cambridge University.

Web Resources:

1. IUCN Red List of Threatened Species: https://www.iucnredlist.org/
2. National Geographic Society - Wildlife Conservation: https://www.nationalgeographic.org/topics/wildlife-conservation.

3. Wildlife Conservation Society: https://www.wcs.org/

Practicum (30hrs)

Sl. No	Contents
1.	Field study/Visit to Zoological Park/Sanctuary/ Natural History Museum/attend Nature Camp and submit a detailed report with photographs.
2.	Biodiversity Register preparation of the college campus or any other area.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the key concepts and terminology in wildlife conservation.	U, R	PSO-1
CO-2	Understand major threats to wildlife populations and habitats, such as habitat loss, climate change, and poaching.	R, U	PSO-2, PSO-3
CO-3	Propose management strategies to mitigate human-wildlife conflicts in different contexts.	U, Ap	PS0-1,
CO- 4	Evaluate the effectiveness of conservation policies and practices in different regions.	An	PSO-2
CO-5	Apply field identification skills to classify and document wildlife species encountered during fieldwork. Analyse habitat data to identify potential threats to wildlife populations, such as habitat fragmentation or degradation	U, Ap, An	PSO-1,PSO-5, PSO-6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Wildlife Biology and Conservation

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PS O	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

CO-1	Understand the key concepts and terminology in wildlife conservation.	PO1 PSO-1	U,R	F,C	L	
CO-2	Recall the major threats to wildlife populations and habitats, such as habitat loss, climate change, and poaching.	PO5 PO8 PSO-2 PSO-3	R, U	F,C	L	
CO-3	Propose management strategies to mitigate human-wildlife conflicts in different contexts.	PO8 PS0-1	U, Ap	F,C	L	
CO- 4	Evaluate the effectiveness of conservation policies and practices in different regions.	PO8 PSO-2	An	F,C	L	
CO-5	Apply field identification skills to classify and document wildlife species encountered during fieldwork. Analyse habitat data to identify potential threats to wildlife populations, such as habitat fragmentation or degradation	PO6 PO8 PSO1 PSO5 PSO-6	U, Ap, An	F,C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PS O5**	**PSO 6**	**PS O7**	**PSO 8**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**

CO 1	3	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	1	-	-	2
CO 3	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 4	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 5	2	-	-	-	3	3	-	-	-	-	-	-	-	2		2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment /Seminar topics

- Human-Wildlife Conflict
- Ecosystem Services
- Climate Change and Wildlife
- Protected Areas Management
- Conservation Education and Outreach

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓

CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK1DSCZOO104**				
Course Title	**Human Nervous System and Behaviour**				
Type of Course	**DSC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in class XII				
Course Summary	The course imparts basic knowledge on the role of different components of the nervous system in human behaviour. Through the course the learner shall get a comprehensive understanding of the major components of the nervous system in human behaviour and the impact of drug abuse and the physiological basis of drug addiction.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Human nervous system**	**15**
	1.1	Divisions of the human nervous system: central and peripheral nervous systems- somatic and autonomic systems-sympathetic and parasympathetic systems, cranial nerves and spinal nerves	4
	1.2	Structure of neuron, types of neurons – myelinated and unmyelinated; unipolar, bipolar and multipolar; sensory, motor and interneurons	3
	1.3	Glial Cells- Schwann cells, microglia, oligodendrocytes, satellite cells, ependymal cells (brief account)	2
	1.4.	Major structures of human brain and functions – cerebrum, cerebral cortex, stellate and pyramidal cells, thalamus, hypothalamus, limbic system and its components, midbrain, pons varolii, cerebellum Spinal cord- structure and functions	6
	Related activities: *1. Construction of a model of the human brain showing its parts. (Group Activity).* 2. *Prepare a flowchart of parts of brain and their functions.*		
11		**Neurophysiology**	**10**
	2.1	Nerve impulse generation and transmission – resting membrane potential, action potential, hyperpolarization, saltatory conduction, threshold stimulus and latent period, all or none law, refractory period	4
	2.2	Synaptic transmission-chemical and electrical transmission, synaptic delay, synaptic fatigue	2

	2.3	Neurotransmitters – excitatory and inhibitory – acetyl choline, noradrenaline, aspartic acid, glutamic acid, serotonin, histamine, adrenalin, glycine, GABA, dopamine (brief account of their major functions)	2
	2.4	Reflex actions- somatic and visceral, reflex arc	2
III	**Brain and behaviour**		**13**
	3.1.	Cerebral lateralization and handedness, interhemispheric differences and sex differences in cerebral functions	5
	3.2.	Language functions of cerebral cortex - Wernicke's area, Broca's area, motor cortex, Arcuate fasciculus, Wernicke- Geshwind model of language perception and production	5
	3.3.	Brain damage and language - Wernicke's aphasia, Broca's aphasia, conduction aphasia, global aphasia, transcortical aphasia	3
	Related activity: *Students can conduct right and left handedness surveys in class room/campus to identify cerebral lateralization.*		
IV	**Monitoring and measuring brain activity**		**14**
	4.1.	EEG (mention different types of brain waves), CT Scan, PET Scan, MRI and functional MRI, Cerebral blood flow (CBF)	9
	4.2.	Brain lesioning and deep brain stimulation (mention stereotactic surgery), Transcranial Magnetic Stimulation	5
	Related activity: *Visit a medical diagnostic centre and prepare a report, including photographs, on the workings of brain monitoring devices.*		
V		**Drug addiction and brain activity**	**8**
	5.1.	Drug abuse: cocaine, heroin, marijuana, LSD, MDMA (brief account)	3
	5.2.	Drug dependence and addiction, drug tolerance, cross tolerance and withdrawal syndrome	3
	5.3.	Drugs and reward circuits: dopamine, nucleus accumbens, prefrontal cortex and dorsal striatum	2
	Related activities: 1. *Preparation of lists of available drugs and conducting awareness campaigns. 2. Conduct workshops/awareness street play on the impact of drug abuse and addiction. 3. Invited talks by psychologists or psychiatrists focusing on the prevention of drug abuse and personality disorder.*		

References:

1. S. Marc Breedlove, Neil Verne Watson and Mark R. Rosenzweig (2010) Biological Psychology: An introduction to behavioural, cognitive and clinical neuroscience, 6th Edition, Sinauer Associates, Incorporated Publishers.

2. Arthur C. Guyton and C.E. Hall (2010) Text Book of Medical Physiology, Elsevier Publishers.

3. Sabyasachi Sircar, (2008) Principles of Medical Physiology, 2nd Edition, Thieme Publishers.

4. James W. Kalat (2009) Biological Psychology, 10th Edition, Wadsworth

5. John P.J. Pinel, Biopsychology, Pearson International, 9th Edition

6. NCBI. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5129843/

7. NCBI.https://nida.nih.gov/publications/drugs-brains-behavior-science-addiction/drugs-brain

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	The study helps the students to understand the components of the human nervous system and their functions.	U	PSO-1
CO-2	Students learn the mechanism of neural co-ordination in the human body and the role of neurotransmitters.	R, U	PSO-3
CO-3	Students can apply the knowledge in analysing individual differences in human behaviour.	U, An	PSO-2
CO-4	The study could apply their knowledge in preventing drug addiction in human society.	Ap	PSO-1
CO-4	The study enables the students to identify various drugs used by drug abusers and gain awareness of the consequences of abnormal thinking.	U, Ap	PSO-1

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Human Nervous System and Behaviour
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

1	The study helps the students to understand the components of the human nervous system and their functions.	PO1/ PSO1	U	C	L	
2	Students learn the mechanism of neural co-ordination in the human body and the role of neurotransmitters.	PO1,PO2 /PSO3	R,U	F,C	L	
3	Students can apply the knowledge in analysing individual differences in human behaviour.	PO1,PO3 /PSO2	U, An	C, F	L	
4	The study could apply their knowledge in preventing drug addiction in human society.	PO1,PO2 /PSO1	AP	F, P	L	
5	The study enables the students to identify various drugs used by drug abusers and gain awareness of the consequences of abnormal thinking.	PO1,PO2 /PSO1	U, Ap	F, P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	3	-	-	-	-	-	3	-	-	-	-	-
CO 2	-	-	2	-	-	-	3	2	-	-	-	-
CO 3	-	2	-	-	-	-	2	-	2	-	-	-
CO 4	3	-	-	-	-	-	3	2	-	-	-	-
CO 5	2	-	-	-	-	--	3	1	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ seminar topics

1. Labelled diagram of the human brain
2. Types of neurons
3. Different types of glial cells
4. Chemical nature of neurotransmitters
5. Age related changes in EEG
6. Natural and synthetic drugs of abuse

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Test
4. Model preparation

End Semester evaluation

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Essay type questions

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK1MDCZOO101**				
Course Title	**Health and Sex Education**				
Type of Course	**MDC**				
Semester	I				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	0	--	3
Pre-requisites	Pass in Class XII				
Course Summary	This course provides an extensive review of health, encompassing physical, mental, emotional, social, and spiritual well-being, along with factors affecting health such as diet, pathogens, pollution, sleep, exercise, and stress. It explores human reproductive physiology, covering the male and female reproductive systems, hormonal control, fertilization, pregnancy, lactation, puberty, adolescence, and senescence, while also addressing topics like contraception, assisted reproductive techniques, adolescent sexuality, gender diversity, sexually transmitted diseases, and sex education, emphasizing their significance in modern India. By emphasizing the importance of comprehensive sex education for youth, the course aims to promote adult sexual health, provide essential information, and develop decision-making skills for the future.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Holistic health and Wellbeing**		**9**
	1.1	Concept of Health- scope and definition (WHO), Health as a state of wellbeing, Factors affecting health- food, balanced diet, pathogens, pollution, sleep, exercise and stress.	2
	1.2	Dimensions of health- physical, mental, emotional, social and spiritual (Brief account only).	3

	1.3	Health programmes and initiatives-Health awareness, Community health centres and its role, Health mission and programmes, Role of Vaccines. **Related activity:** *Students are advised to visit a Community Health care centre and submit a report with photos.*	4
II	**Human Reproductive Physiology**		**13**
	2.1	Male reproductive system- structural details of testis and accessory structures, functions of testis, semen, hormonal control.	3
	2.2	Female reproductive system- structure of ovary, accessory structures, reproductive cycles and hormonal control, menstrual cycle, hysterectomy, menopause.	3
	2.3	Fertilization, gestation period, Pregnancy, parturition and lactation.	3
	2.4	Puberty, adolescence (physical and biological aspects) and senescence- Mention Stress management techniques.	4
III	**Human interference in reproduction**		**8**
	3.1	Contraception-Barrier methods, hormonal and sterilisation procedures. Fertility awareness methods.	4
	3.2	Abortion (MTP) and Assisted Reproductive Techniques- IVF, GIFT, ZIFT, DI. **Related activity:** *Prepare Charts/ Videos/ drawings to create awareness about Health and Sex.*	4
IV	**Adolescent Sexuality and Gender Diversity**		**7**
	4.1	Sexuality- Definition, Adolescent sexual activity, teenage pregnancy, Sexual abuse, assault and harassment.	4
	4.2	Gender diversities and Sexual Orientation, LGBTQ- Lesbian, Gay sex, Bisexual, Transgender and Qeer. **Related activity:** *Develop scripts for skits or role-plays that address issues related to sexual abuse, harassment, and respecting gender diversity.*	3
V	**Sexually Transmitted Diseases (STDs) and Sex Education in India**		**8**
	5.1	Definition of Sexually Transmitted Diseases with the following examples: Symptoms, Diagnosis, Treatment and Prophylaxis of Syphilis, Chlamydia, Trichomoniasis, Gonorrhoea, Genital herpes and AIDS.	4
	5.2	Sex Education -Definition, types, Importance of Sex education among youths, scope and awareness programmes.	2
	5.3	Relevance of Sex Education for children in Modern India: Role of parents, schools, youth and society; Legal aspects and policies. **Related activities:** *1. Create multimedia presentations or awareness campaigns advocating for sexual and reproductive rights.* *2. Conduct workshops or guest talks focusing on sexuality education, consent, and healthy relationships.*	2

References

1. Agarwal, S., & Gupta, P. (2019). Women's Health and Education. Jaypee Brothers Medical Publishers.
2. Arora, V. (2018). Health Education: Principles and Methods. PHI Learning Pvt. Ltd.
3. Garzón-Orjuela N, Samacá-Samacá D, Moreno-Chaparro J, Ballesteros Cabrera MDP, Eslava-Schmalbach J. (2021) Effectiveness of Sex Education Interventions in Adolescents: An Overview. *Compr Child Adolesc Nurs*.; 44(1):15–48.

4. International Institute for Population Sciences (IIPS) & ICF. (2017). National Family Health Survey (NFHS-4), India.
5. Paul, B. (2017). Health Education and Community Pharmacy. Elsevier.
6. R S Vander Gaag, MGG Walpot and L Boendermaker (2024) Professional competencies for sexuality and relationships education in child and youth social care: A scoping review
7. Ross and Wilson (2011), Anatomy and physiology in Health and Illness, 11th Edition, Church Hill Livingstone.

Web Resources

1. https://www.mohfw.gov.in/
2. https://ab-hwc.nhp.gov.in/home/login
3. https://www.sexandu.ca/consent/online-safety/
4. https://portal.ct.gov/-/media/dmhas/skillbuilding/dana/health-and-wellness-full-revised.pdf
5. https://www.who.int/data/gho/data/major-themes/health-and-well-being

Course Outcomes

CO Nos	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
1	Understand the concepts of health and wellbeing, including physical, mental, social, emotional, and spiritual health, as well as factors affecting health, and role of vaccines.	U, R	PSO 1
2	Describe the anatomy and functions of the male and female reproductive systems, including hormonal regulation and reproductive processes and analyse the stages of human development from puberty through adolescence to senescence.	A	PSO 2
3	Compare different contraception methods and make informed decisions regarding their use based on individual health needs and preferences	R, C	PSO 1
4	Analyse the processes and ethical considerations involved in pregnancy, abortion and various assisted reproductive techniques understanding their implications for reproductive health and family planning.	An	PSO 3, PSO 8
5	Identify and differentiate between common sexually transmitted diseases including their respective symptoms, transmission modes, and risk factors.	R, U	PSO 8
6	Evaluate and advocate for the integration of comprehensive sex education into school curricula and community health initiatives, emphasizing the importance of informed decision-making and respect for sexual rights.	E, C	PSO 1, PSO 2
R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create			

Name of the Course: Human Health and Sex Education
Credits: 3:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the concepts of health and wellbeing, including physical, mental, social, emotional, and spiritual health, as well as factors affecting health and role of vaccines.	PO 1/ PSO 1	U, R	F, C	L	-
2	Describe the anatomy and functions of the male and female reproductive systems, including hormonal regulation and reproductive processes and analyse the stages of human development from puberty through adolescence to senescence.	PO 2/ PSO1/ PSO2/ PSO4	A	F, C	L	-
3	Compare different contraception methods and make informed decisions regarding their use based on individual health needs and preferences.	PO 1 /PSO1/PSO2/PSO3	R, C	F, C	L	-
4	Analyse the processes and ethical considerations involved in pregnancy, abortion and various assisted reproductive techniques understanding their implications for reproductive health and family planning.	PO 2/ PO 8/ PSO3/ PSO4	An	C	L	-
5	Identify and differentiate between common sexually transmitted diseases including their respective symptoms, transmission modes, and risk factors.	PO 8/ PSO1/PSO2	R, U	F	L	-

6	Evaluate and advocate for the integration of comprehensive sex education into school curricula and community health initiatives, emphasizing the importance of informed decision-making and respect for sexual rights.	PO 2/PO 8/ PSO1/ PSO 4	E, C	P	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	1	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 2	2	2	-	2	-	-	-	-	2	-	-	-	-	-	-
CO 3	1	2	1	-	-	-	-	1	-	-	-	-	-	-	-
CO 4	2	-	2	3	-	-	-	-	1	-	-	-	-	-	2
CO 5	1	1	-	-	-	-	-	-	-	-	-	-	-	-	2
CO 6	1	-	-	3	-	-	-	-	1	-	-	-	-	-	2

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment /Seminar topics

1. Factors affecting Health
2. Structure of Male reproductive system

3. Structure of Female reproductive system
4. Physical and biological aspects of Adolescence
5. Assisted Reproductive techniques
6. Teenage Pregnancy and Sexual abuse
7. Contraceptives
8. Lifestyle diseases
9. Role of Vaccines in public health
10. Sexually transmitted diseases
11. Importance of Sex Education in Today's Scenario

Continuous Comprehensive Assessment

1. Quiz
2. Assignment
3. Submission of Report
4. Monitoring of yoga and exercise
5. Group discussion
6. Test

End Semester assessment

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO5	✓	✓		✓
CO 6	✓	✓		

SEMESTER II

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK2DSCZOO101**				
Course Title	**Non - Chordate Diversity-Part II**				
Type of Course	**DSC**				
Semester	**II**				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	0	2 hours	5
Pre-requisites	Pass in class XII				
Course Summary	This course provides the students with an in-depth knowledge of the diversity in form, structure and habits of coelomata. This course also provides students with a comprehensive understanding of the diverse world of invertebrates and the evolutionary significance of coelomates in the animal kingdom. Through lectures, discussions, and hands-on activities, students will gain insight into the remarkable adaptations and ecological roles of these fascinating organisms.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Coelomates**		**2**
	1.1	Evolution of coelom and metamerism	2
II	**Annelida**		**5**
	2.1	General characteristics and classification (up to classes)	1
	2.2	Polychaeta: eg. *Nereis* (mention *heteronereis*), Oligochaeta: eg. Earthworm. Hirudinea: eg. Leech.	2
	2.3	General topic: Vermicomposting	2

III	**Arthropoda and Onychophora**		**18**
	3.1	Arthropoda: General characters	2
	3.2	Type- Penaeus; Morphology, digestive, respiratory, circulatory, nervous, excretory and reproductive systems. Appendages and larval forms.	7
	3.3	Brief account on Limulus, Eupagurus, Sacculina, *Apis indica*, *Bombyx mori* and Drosophila.	4
	3.4	General topic : Social life in honey bees, termites and ants	3
	3.5	General characters of Onychophora	1
	3.6	*Peripatus* (Evolutionary significance).	1
IV	**Mollusca**		**10**
	4.1	General characteristics and classification (up to classes)	1
	4.2	Monoplacophora: eg. Neopilina, Polyplacophora: eg. Chiton, Aplacophora: eg. Neomenia, Gastropoda: eg. Pila, Scaphopoda: eg. Dentalium, Pelecypoda*:* eg. Perna, Cephalopoda: eg. Sepia.	5
	4.3	General topic: Economic importance of mollusca, Pearl culture. Mussel culture.	4
V	**Echinodermata**		**10**
	5.1	General characteristics and classification (up to classes).	1
	5.2	Asteroidea: eg. Asterias, Ophiuroidea: eg. Ophiothrix, Echinoidea: eg. Echinus, Holothuroidea: eg. Sea cucumber, Crinoidea: eg. Sea lily.	5
	5.3	General Topic: Water-vascular system and Larval forms in Echinodermata	4

References

1. Barnes, R.D. (1987): Invertebrate Zoology. W: B. Sunders. New Delhi.
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. (1967). Invertebrate Structure and Function. ELBS and Nelson, London.
4. Brusca, R.C . and G. J. Brusca. (1940). Invertebrates. Sinauer Associates, Sunderland, M.A.

5. Ekambaranatha Ayyar M. (1990). A Manual of Zoology. Vol. Invertebrata- Part1 & PartII. S. Viswanathan Printers and Publishers. Pvt. Ltd.
6. Hyman, L. H. (1942). The invertebrate volumes. Mc Gew Hill
7. Jordan, EL and Verma, P.S. (2000). Invertebrate Zoology. S. Chand and Co Ltd. New Delhi.
8. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders
9. International Edition
10. Woese CR, Kandler O, Wheelis ML (June 1990). "Towards a natural system of organisms: proposal for the domains Archaea, Bacteria, and Eucarya". Proceedings of the National Academy of Sciences of the United States of America. 87 (12): 4576–9

Web Resources

1. https://eol.org
2. http://www.tolweb.org
3. https://www.marinebio.org/creatures/marine-invertebrates
4. https://www.montereybayaquarium.org/animals/animals

Practicum (30 hrs)

Sl No.	Contents
1.	Study of following specimens: Annelida - Nereis, Hirudinaria, Earthworm Arthropoda - Limulus, Sacculina, Eupagurus, Bombyx, honey bees Onychophora – Peripatus Mollusca - Chiton, Dentalium, Pila, Pinctada, Sepia Echinodermata - Asterias, Echinus, Sea cucumber, Sea lily
2.	Mount the body setae of Earthworm/ Nereis parapodia/ Wing scales of butterfly/Radula of Sepia (any one).
3.	Mount the mouth parts of Cockroach / Honey bee/ mosquito (any one).
4.	Mount the appendages of prawn.
5.	Dissection of nervous system of prawn/ Cockroach (any one).
6.	Dissection of digestive system of Cockroach.
7.	Submit field report after visiting a Life science Research Institute (preferably CMFRI/ZSI).
8.	Submit a report on any 5 Crustaceans, Annelids, Molluscs and Echinoderms.

References

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. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
3. Boradale, L.A. and Potts, E.A. (1961). Invertebrates: A Manual for the use of Students. Asia Publishing Home .
4. Brusca, R.C, Giribet G, and Moore W (2023). Invertebrates (fourth edition). Sinauer Associates, Sunderland, M.A. Oxford University Press, USA.

5. Dhami. P.S and Dhami, J. K. (1979). Invertebrate zoology. R. Chand & Co. New Delhi.
6. Ekambaranatha Ayyar M. (1990). A Manual of Zoology. Invertebrata- Part1 & PartII. S. Viswanathan Printers and Publishers. Pvt. Ltd.
7. Henry Sherring Pratt (2015). A Course in Invertebrate Zoology: A Guide to the Dissection and Comparative Study of Invertebrate Animals. Palala Press.
8. Jordan, EL and Verma, P.S. (2000). Invertebrate Zoology. S. Chand and Co Ltd. New Delhi.
9. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the evolution of coelom and metamerism	U	PSO-1,3
CO-2	Understand the diagnostic characters of different phyla through brief studies of examples	R, U	PSO-1, 3
CO-3	Obtain an overview of evolutionary significant, parasitic and economically important species of coelomate	R,U	PSO-1, 4
CO-4	Apply identification skill, to observe and categorise organism	Ap	PSO-6
CO-5	Learn anatomy by dipping through simple dissections and mountings on permitted species	Ap	PSO-6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Non - Chordate diversity-Part II

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the evolution of coelom and metamerism	PO-2/PSO -1,3	U	F	L	
CO-2	Understand the diagnostic characters of different phyla through brief studies of examples	PO-1,2/PSO -1, 3	R, U	F,C	L	
CO-3	Obtain an overview of evolutionary significant, parasitic and economical important species of coelomate	PO-3/PSO -1, 4	R, U	F,C	L	
CO-4	Apply field identification skill, to identify and categorise organism	PO-6/PSO -6	Ap	F,C,P		P
CO-5	Learn anatomy by dipping through simple dissections and mountings on permitted species	PO-6/PSO -6	Ap	F,C,P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	-	-	-	-	-	2	-	-	-	-	-
CO2	3	-	3	-	-	-	-	-	3	-	-	-	-	-
CO3	2	-	-	3	-	-	-	-	-	2	-	-	-	-
CO4	-	-	-	-	-	3	-	-	-	-	-	-	3	-
CO5	-	-	-	-	-	3	-	-	-	-	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ / Seminar topics

1. Vector borne diseases – Dengue fever, Japanese Encephalitis, Malaria, Cutaneous leishmaniasis
2. Economic importance of Molluscs
3. Social life in honey bees
4. Larval forms of Penaeus
5. Water vascular system in Echinodermata

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Submission of activity report

4. Test
5. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer questions
4. Essay Type questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4				✓
CO5				✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK2DSCZOO102**				
Course Title	**Wildlife Ecology**				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	hours	4
Pre-requisites	Pass in class XII				
Course Summary	The course provides an exploration of wildlife ecology and behaviour, human-wildlife interactions, emphasizing the importance of understanding these dynamics in conservation planning. It covers aspects such as wildlife management techniques, human-wildlife conflict management, environmental impact assessment and research techniques, equipping them with practical skills to address real-world conservation challenges.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I	**Introduction to Wildlife ecology**		**8**
	1.1	Definition and scope of wildlife ecology, Different types of forests (Brief description)	2
	1.2	**Ecological Principles**: Population dynamics: growth, regulation, and interactions; Community ecology: species interactions, trophic levels, and biodiversity	2
	1.3	**Habitat Ecology**; Types of habitats and their characteristics, Habitat selection and utilization by wildlife species	2

	1.4	**Wildlife Adaptations**; Behavioural and physiological adaptations of wildlife species; Adaptations to different habitats and environmental conditions	2
II		**Wildlife Population Dynamics**	**8**
	2.1	**Population Monitoring Techniques**: Sampling methods: Direct count, (Block count, Transect methods, Point count, Visual encounter survey, Waterhole survey), Indirect count (Cell count, Track and signs, Pellet count, Pug mark and Camera count) and remote sensing and GIS applications in wildlife research.	8
III		**Wildlife Behaviour and Ecology**	**12**
	3.1	**Migration and Dispersal**: Causes and patterns of migration; Ecological significance of dispersal in wildlife populations	3
	3.2	**Communication and Social Organization**: Types of communication in wildlife; Social structure and organization in wildlife populations	3
	3.3	**Territoriality and Home Range**: Concepts of territoriality and home range, Factors influencing territory size and shape	3
	3.4	**Human-Wildlife Interactions**: Understanding human-wildlife interactions; Impacts of human activities on wildlife behaviour and ecology.	3
IV		**Wildlife Conservation**	**17**
	4.1	**Conservation Strategies**: Protected areas: types, design, and management; Habitat conservation: restoration, enhancement, and creation (In-situ and Ex-situ Conservation strategies –Brief Account) **Community-Based Conservation**: Principles and approaches of community-based conservation –in India and Kerala **Related activity:** *Field study – Visit to a Zoo/ Zoological Park/ Natural History Museum and Submit a detailed report with photographs/ Prepare a list of birds in the Zoo.*	5
	4.2	**Wildlife Laws and Policies**: Overview of wildlife laws and policies in India; IWPA 1972 and its ramifications; Role of international conventions and treaties in wildlife conservation (Brief Account only) Gadgil Commission & Kasturirangan Commission.	5
	4.3	**Case studies of successful community-based conservation projects**; Project Tiger, Project Elephant, Project Crocodile and Project Cheetah (Brief Account only). Threatened Species Conservation; Conservation status and threats to endangered species; Conservation efforts for flagship and keystone species; Control of Invasive species in forests with special reference to Kerala Forests.	7
V		**Applied Wildlife Ecology**	**15**

	5.1	**Wildlife Management Techniques**: Population control methods: culling, contraception, and translocation; Disease management in wildlife populations	4
	5.2	**Human-Wildlife Conflict Management**: Causes and mitigation strategies for human-wildlife conflicts. Conflict resolution through stakeholder engagement and conflict-sensitive conservation	5
	5.3	**Environmental Impact Assessment:** Principles and procedures of EIA; Role of wildlife ecology in EIA for development projects (brief account only).	2
	5.4	**Research Techniques in Wildlife Ecology**: Field research methods: trapping, tracking, and observation techniques; Non-invasive studies- eDNA, Photogrammetry and AI. Data analysis and interpretation for wildlife ecology research.	4

References

1. S K Singh (2010) Text Book of Wildlife Management International Book Distributing Company, Lucknow.
2. Vivek Menon (2014) Indian Mammals: A Field Guide Hachette Book Publishing India Pvt Ltd, Gurgaon.
3. S S Negi (1992) Himalayan Wildlife. Indus Publishing Company, New Delhi.
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5. Richard Carmichael (2007). Indian Wildlife. Apa Publications GmbH Co.Vertag KG (Singapore).
6. C. Michael Hall and Stephen Boyd (2006) Nature based tourism in peripheral areas - Development or disaster? Viva Books Pvt Ltd New Delhi.
7. Ministry of Environment & Forests GoI, (2002), National Biodiversity Strategy & Action Plan
8. Krebs C. J (1985). The experimental analysis of distribution and abundance. Ecology. Harper and Row, New York.
9. Odum, E.P. & Barrett, G W. (1953) Fundamentals of Ecology, Philadelphia.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental principles and scope of wildlife ecology, including population dynamics, community ecology, habitat ecology, and wildlife adaptations.	U, An	PSO-1
CO-2	Demonstrate proficiency in population monitoring techniques such as mark-recapture, transect surveys, and remote sensing for estimating population parameters.	R, U	PSO-2,5,6
CO-3	Evaluate various aspects about wildlife behaviour, ecology and human wildlife conflicts	U, A	PSO-3

CO-4	Evaluate different conservation strategies, Interpret wildlife laws, policies, and international conventions related to wildlife conservation	U, A	PSO-3
CO-5	Demonstrate proficiency in research techniques in wildlife ecology, including field research methods, data analysis, and interpretation.	A	PSO-1,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Wildlife Ecology
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the fundamental principles and scope of wildlife ecology, including population dynamics, community ecology, habitat ecology, and wildlife adaptations.	PO-1/PSO-1	U, An	F, C	L	
2	Demonstrate proficiency in population monitoring techniques such as mark-recapture, transect surveys, and remote sensing for estimating population parameters.	PO-5/PO-8/PSO-2/PSO-5/PSO-6	R, U	F,C	L	

3	Evaluate various aspects about wildlife behaviour, ecology and human wildlife conflicts	PO-1/PSO-3	U,A	F	L	
4	Evaluate different conservation strategies, Interpret wildlife laws, policies, and international conventions related to wildlife conservation	PO-8/PSO-3	An, A	F,C	L	
5	Demonstrate proficiency in research techniques in wildlife ecology, including field research methods, data analysis, and interpretation.	PO-5/PO-7/PSO-1/PSO-7	U,Ap, An	F, C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	2	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 2	-	2	-	-	1	2	-	-	-	-	-	-	3	-	-	2

CO3	-	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	3
CO 5	2	-	-	-	-	-	2	-	-	-	-	-	3	-	2	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assignment /Seminar Topics

- Prof. Madhav Gadgil and Kasturirangan Report
- Different types of forests
- Human wildlife conflict
- Biodiversity Hotspots – Western Ghats
- Community based conservation
- Population monitoring techniques

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Test
4. Quiz/ Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer questions
4. Essay Type questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK2DSCZOO103**				
Course Title	**Aquatic Ecosystems and Sustainable Management**				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 - 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in class XII				
Course Summary	This course shall provide a comprehensive understanding of structure function and dynamics of aquatic ecosystems and enable the student to understand and analyse the interrelations and importance of biotic and abiotic factors. This course is designed to understand and explore the impact of human activities on aquatic ecosystems. The course also covers principles and strategies for sustainable management of aquatic resources, focusing on conservation and restoration.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Aquatic ecosystems**	**10**
	1.1	Introduction and definition of aquatic ecosystems	1
	1.2	Types of Freshwater ecosystems – Lentic, Lotic and Wetlands	2
	1.3	Types of Marine ecosystems – Littoral zone, Neritic zone and oceanic zone	2
	1.4	Types of Brackish water ecosystems – Estuaries, backwaters and lagoons	1

	1.5	River continuum concept–streams	1
	1.6	Marine benthic zones and coral reefs– their significance	1
	1.7	Important aquatic ecosystem spots in Kerala (Vembanad, Sasthamkotta, Kadalundi mangrove system, Periyar river system and its reservoirs)	2
II	**Animals in aquatic ecosystems**		**10**
	2.1	Role of aquatic diversity in ecosystem stability and resilience	2
	2.2	Adaptations of aquatic animals in lentic and lotic systems– deep-sea animals, aquatic insects and benthos	5
	2.3	Phytoplankton, Zooplankton, Nekton and Neuston **Related Activity** - *Collection of Zooplankton using plankton nets.*	1
	2.4	Bioindicators – Definition and importance in aquatic ecosystem	2
III	**Abiotic factors of aquatic ecosystems**		**10**
	3.1	Chemical properties of water – pH, Dissolved oxygen, Carbon dioxide, BOD, COD **Related Activity** - *Sampling and collection of water samples from a nearby water body and analyse the important physico chemical parameters.*	3
	3.2	Physical factors in aquatic systems– Light-Zonation, Temperature and Thermal stratification, Turbidity, Dissolved solids	3
	3.3	Classification of lakes and marine systems based on light zonation	2
	3.4	Nutrient Cycles in aquatic ecosystems (Carbon, Nitrogen and phosphorus Cycles)	2
IV	**Challenges faced by aquatic ecosystems**		**15**
	4.1	Physical alterations: Changes in water temperature, availability of light and flow modifications of water.	3
	4.2	Chemical alterations: Nutrient overload, presence of harmful chemicals, oxygen depleting activities	4
	4.3	Biological alterations: Overfishing, introduction of invasive species	4

	4.4	Impact of Plastic and Micro plastic pollution **Related Activity** - *Study the effect of plastic pollution and propose mitigation strategies.*	4
V	**Conservation and Management of aquatic systems**		**15**
	5.1	Systematic Conservation Planning for aquatic ecosystems	2
	5.2	Principles of ecosystem-based management for aquatic ecosystem	2
	5.3	Integrated water resource management (IWRM) approaches – (Brief description on importance)	2
	5.4	Conservation strategies for aquatic biodiversity: Protected areas, restoration	3
	5.5	Importance of traditional ecological knowledge in aquatic biodiversity conservation	3
	5.6	Indigenous knowledge systems for sustainable aquatic resource management	3

References

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3. Odum, E.P. 1971. Ecology. Holt Riehart& Winston Inc., USA, 152 pp.
4. Sharma, B. K. (2016). Environmental Science: Water Pollution and Management. Rastogi Publications.
5. Kalff, J. (2002). Limnology: Inland Water Ecosystems. Prentice Hall.
6. Prasad, B., & Sharma, C. (2019). Sustainable Management of Aquatic Resources. CRC Press.
7. Datta, S. C., & Chattopadhyay, G. N. (2017). Ecology of Plankton. Springer.
8. Keshaviah, P. (Ed.). (2014). Water Resources, Policies, and Politics in India: Initiatives and Challenges. Routledge.

Web Resources

1. International Union for Conservation of Nature (IUCN) - Freshwater Conservation: https://www.iucn.org/theme/freshwater.

2. Central Pollution Control Board (CPCB), India: http://www.cpcb.nic.in/
3. National Institute of Oceanography (NIO), India: https://www.nio.org/
4. Ministry of Environment, Forest and Climate Change, Government of India: http://moef.gov.in/
5. Indian Council of Agricultural Research (ICAR) - Central Inland Fisheries Research Institute: https://cifri.icar.gov.in/
6. National Institute of Oceanography, India: https://www.nio.org/
7. National Mission for Clean Ganga, Government of India: https://nmcg.nic.in/
8. World Wide Fund for Nature (WWF) - India: https://www.wwfindia.org/

9. United Nations Environment Programme (UNEP) - India: https://www.unep.org/explore-topics/resource-efficiency/what-we-do/resource-efficiency-and-chemicals/regions/asia-and-87

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop a critical thinking based on comprehensive knowledge and understand different types of aquatic ecosystems.	R, U, An	PSO-1,2
CO-2	Analyse and describe the interactions between biotic and abiotic components within different ecosystems and understand how these interactions contribute to ecosystem stability	C, U, An, E	PSO- 2
CO-3	Recognise the ecosystem services provided by different types of ecosystems.	U, An, E	PSO-2,3
CO-4	Identify and categorise the major threats faced by aquatic ecosystems such as pollution, habitat destruction, overfishing etc.	R, U, An	PSO-3,4
CO-5	Assess the impact of human activities on different ecosystems including different habitat destructions, pollution and climate change including man made effects.	U, An, E,C	PSO-2,3,4,7
CO-6	Students will get awareness and develop skills to convey scientific concepts to diverse audiences, including policy makers, stakeholders and the general public.	C, An, E, Ap	PSO-5,6,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Aquatic Ecosystems and Sustainable Management
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practicam (P)
CO-1	Develop a comprehensive knowledge and understand different types of aquatic ecosystems	PO-1,2,3,4 PSO-1,2,3,4	R, U, An	F, C	L	-

CO-2	Analyse and describe the interactions between biotic and abiotic components within different ecosystems and understand how these interactions contribute to ecosystem stability.	PO-1,2,3,4 PSO-1,2,3,4	C, U, An, E	F, C	L	-
CO-3	Recognise the ecosystem services provided by different types of ecosystems.	PO-3,4,6,7,8 PSO-5,6,7,	U, An, E	F, C	L	
CO-4	Identify and categorise the major threats faced by aquatic ecosystems such as pollution, habitat destruction, overfishing etc.	PO-1,2,3,4 PSO-1,2,3,5,6,7	R, U, An	F, C, P	L	
CO-5	Assess the impact of human activities on different ecosystems including different habitat destructions, pollution and climate change including man made effects.	PO-5,6,7,8 PSO-5,6,7	U, An, E,C	F, C,M	L	
CO-6	Students will get awareness and develop skills to convey scientific concepts to diverse audiences, including policy makers, stakeholders and the general public.	PO-3,4,5,6,7 PSO-4,5,6,7	C, An, E, Ap	F, C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PS0 7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	3	2	1	1	-	-		3	2	1	-	-	-	-	-
CO 2	2	3	2	1	-	-		2	3	2	3	-	-	-	-
CO 3				-	3	3	2			3	3	-	1	1	1
CO 4	1	2	3	3	2	2	2	2	2	2	3	3	-	-	-
CO 5	-	-	-		3	3	2					3	3	3	2
CO 6	-	-	-	3	2	1	1				3	2	1		

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/Seminar topics

1. Impact of climate change on aquatic ecosystem
2. Aquatic adaptation of deep-sea animals
3. Economic analysis of ecotourism in aquatic ecosystems and its role in conservation.
4. Impact of Plastic and Micro plastic pollution on aquatic ecosystem
5. Important aquatic ecosystem spots in Kerala

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Test
5. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Question
2. Very Short Answer Question
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK2DSCZOO104**				
Course Title	**Sensory Physiology**				
Type of Course	**DSC**				
Semester	II				
Academic Level	100 – 199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in Class XII				
Course Summary	This course provides basic knowledge about the sense organs and the mechanisms by which humans receive information about their environment through sensory organs. The learner shall understand the functional anatomy of the main sense organs in our body.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Photoreceptors**	**14**
	1.1	Structure of human eye- mention rods and cones	3
	1.2	Physiology of vision, visual pigments, optics of vision (binocular vision and accommodation), light and dark adaptation	4
	1.3	Theories of colour vision-Trichromatic theory, Opponent-process theory	3
	1.4	Visual pathway from retina to cortex, neural basis of colour vision	2

	1.5	Visual defects- myopia, hypermetropia, presbyopia, astigmatism, cataract, glaucoma, amblyopia, colour blindness (brief account only)	2
	Related activity: *Students are directed to conduct a survey based on visual defects among school or college students and present the report.*		
II	**Audio receptors**		**12**
	2.1	Structure of ear- Anatomy and functions of structural components	3
	2.2	Mechanism of hearing	3
	2.3	Auditory pathways-lemniscal and non-lemniscal pathways	4
	2.4	Hearing disorders – sensorineural, conductive and mixed hearing loss , Tinnitus, Meniere's disease (brief account only)	2
	Related activity: *Students are directed to conduct a survey on hearing defects among school or college students and present the report.*		
III	**Chemoreceptors**		**10**
	3.1	Gustation – taste receptors and their mechanisms – perception of taste (salt, bitter, sweet, sour and umami), mention taste pathway	4
	3.2	Olfaction- olfactory receptors, olfactory pathways	4
	3.3	Interaction of taste and smell	1
	3.4	Disorders of olfaction and gustation- anosmia and ageusia (brief account only)	1
	Related activity: *Students can be encouraged to make a PowerPoint presentation on various factors that alter taste perception (group of 5 members).*		
IV	**Cutaneous receptors and proprioceptors**		**9**
	4.1	Touch and pressure receptors- Meissner's corpuscle, Merkel's discs, pacinian corpuscle, Ruffinis's endings (brief account only)	1
	4.2	Thermoreceptors-warm and cold receptors (A-delta fibres and C-delta fibres)	2
	4.3	Position senses- muscle spindle and Golgi Tendon Organ (brief account only)	2
	4.4	Vestibular senses (Labyrinthine sense)- Otolith organs in inner ear, semi-circular canals- crista ampullaris (structure and function)	4
	Related activity: *Power point presentation on "Time perception" (group of 5 members).*		
V	**Pain receptors**		**15**

	5.1	Nociceptors- different types (A-delta fibres, C-fibres, TRP receptors (brief account only).	1
	5.2	Types of pain-acute and chronic pain, neuropathic pain, Phantom limb pain and mirror box, referred and visceral pain	3
	5.3	Clinical abnormalities of pain and other somatic sensations- Hyperalgesia, Thalamic syndrome, Tic Douloureux, Brown- Sequard Syndrome	2
	5.4	Pain suppression system in brain and spinal cord- Ascending and descending pathways, Brain-opiate systems (endorphins and enkephalins) Gate control theory (Melzack and Wall theory).	6
	5.5	Pain treatment and management- opioid and non-opioid analgesics, anti- inflammatory drugs, muscle relaxants, Placebo effect, Acupuncture, TENS (Brief mention only).	3
	Related activity: *Group discussion on Identifying useful tips for managing pain.*		

References

1. Chaudhuri,S.K Concise Medical Physiology New Central Book Agency
2. Guyton,A.C. Text book of Medical Physiology,W.B. Saunders Co
3. Hilgar & Atkinson. Introdution of Psychology.
4. Kalat, J.W. Biological Psychology. CA: Wadsworth.
5. Levintha;. C.F Introduction to Physiological Psychology New Delhi Prentice Hall
6. Schneider, A. M., and Tarshis, B. An Introduction to Physiology. New York Random House.
7. Weiten, W. (2008) Psychology: Themes and variations 7th ed New York: Brooks/Cole.
8. https://www.ncbi.nlm.nih.gov/books/NBK539861/
9. https://www.ncbi.nlm.nih.gov/books/NBK219252/
10. https://www.jax.org/news-and-insights/2019/april/mechanisms-of-sound-perception
11. https://www.aao.org/eye-health/anatomy/parts-of-eye

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Provides a comprehensive understanding of the	U	PSO- 1,**3,4**

	mechanisms underlying visual mechanisms and visual impairments		
CO-2	Examines the anatomy and functions of the structural components of the ear, including the mechanism of hearing and auditory pathways, evaluate disorders etc, which provide students with a comprehensive understanding of the ear's anatomy, function, and common auditory disorders.	U, Ap, An	PSO- 1,**4**
CO-3	Explores the mechanisms of gustation and olfaction, which provides a comprehensive understanding of chemosensation and its related disorders.	U	PSO- 1,**4**
CO-4	Provides a comprehensive understanding of somatosensation and vestibular perception.	U	PSO- 1,**4**
CO-5	Provide a comprehensive understanding of pain mechanisms, disorders, and treatment modalities.	U	PSO- 1,**4**

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Sensory Physiology
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	Provides a comprehensive understanding of the mechanisms underlying visual mechanisms and visual impairments	PO-1,2/ PSO-1,3,4	U	F, C	L	-
2	Examines the anatomy and functions of the structural components of the ear, including the mechanism of hearing and auditory pathways, disorders etc, which provide students with a comprehensive understanding of the ear's anatomy, function, and common auditory disorders.	PO-1,2,8/ PSO- 1,4	U, Ap, An	F, C	L	-

3	Explores the mechanisms of gustation and olfaction, which provides a comprehensive understanding of chemosensation and its related disorders.	PO-1,2,8/ PSO- 1,4	U	F, C	L	-
4	Provides comprehensive understanding of somatosensation and vestibular perception.	PO-1,2/ PSO- 1,4	U	F, C	L	-
5	Provide a comprehensive understanding of pain mechanisms, disorders, and treatment modalities.	PO-1,2/ PSO- 1,4	U	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	2	-	1	3	-	-	-	1	1	-	-	-	-	-	-
CO 2	2	-	-	2	-	-	-	2	1	-	-	-	-	-	1
CO 3	1	-	-	2	-	-	-	1	2	-	-	-	-	-	1
CO 4	2	-	-	2	-	-	-	2	1	-	-	-	-	-	-
CO 5	2	-	-	2	-	-	-	1	1	-	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Assignment/ Seminar topics

1. The role of sensory perception in everyday life

2. Prepare a power point presentation on the working of different sense organs
3. Diseases affecting different sense organs
4. Recent advancements in technology (e.g., virtual reality, neuroimaging) and their applications in studying sensory physiology,

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of PowerPoint presentations
4. Test
5. Quiz/ Debate

End semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer type
4. Essay type

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK2MDCZOO101**				
Course Title	**Global Climate Change**				
Type of Course	**MDC**				
Semester	II				
Academic Level	100-199				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	-	3
Pre-requisites	Pass in Class XII				
Course Summary	The course will develop a comprehensive understanding of Earth system dynamics, climate change impacts, mitigation strategies, and international agreements aimed at addressing global environmental challenges. They will be equipped to analyse environmental data, assess ecological health, and contribute to sustainable practices and policy decisions related to climate change and environmental protection.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Earth System Study**	**9**
	1.1	Concept of the earth system- climate forcing, responses, feedback loops, equilibrium states, Daisyworld model, solar flux at Earth's orbit.	3
	1.2	Evolution of ozone layer; planetary energy balance, seasonal variability. Radiative transfer, an improved estimate of climate sensitivity.	3
	1.3	Global Environmental change issues and challenges - *El Nino, La Nina.*	3
II		**Causes of Climate Change**	**8**
	2.1	Greenhouse gases and their sources; greenhouse effects; causes of depletion of ozone layer and consequences; climate change: effects of enhanced UV radiation on plants, microbes, animals, human health and materials; global energy infrastructure and GHG emissions.	8
III		**Impacts on climate**	**9**

	3.1	Atmospheric deposition: past and present scenario; causes and consequences of excessive atmospheric deposition of nutrients and trace elements; acid rain and its effects on plants, animals, microbes and ecosystems.	5
	3.2	Eutrophication, Consequences on climate, oceans, agriculture, natural vegetation and humans; cloud formation, storms and climate	4
IV	**Future Climate: Scenarios and Projections**		**10**
	4.1	Green Audit - quantitative analysis of flora and fauna, assessment of water bodies, water audit, energy audit, carbon footprint analysis. **Related activity:** *Green audit- (Residence/Campus).*	5
	4.2	Ecological indicators and animal examples (Fishes, Birds and Lichens). Role of INCOIS and IMD. **Related activities:** *1. Preparation of Weather chart preparation (Temperature/Rainfall) - Connect INCOIS, India Meteorological Department* *2. Identification of environmental indicators in Climate change (animals/plants/invasive species) and submission of reports (Lists/pictures).*	5
V	**International summits and agreements**		**9**
	5.1	International efforts on climate change issues. Global efforts for mitigating ozone layer depletion. Climate modelling and climate change feedback (Brief account only).	3
	5.2	International Summits: BRICS, G20, G7, ASEAN, SAARC, Indian Science Congress, NATO. Earth Summit-*Rio de Janeiro.* International agreements: The United Nations Framework Convention on Climate Change, UNFCCC, Kyoto Protocol, Paris Agreement. Swedish environmental activist contribution; Greta Thunberg (Brief account). Integrated Assessment models: Asia Pacific Integrated models; SASCOF model; Multiregional Approach for Resource and Industry Allocation Model (MARIA); Intergovernmental Panel on Climate Change (IPCC) and Emissions budgets.	6

References

1. Adger, N.; Brown, K. and Conway, D. (2012). Global Environmental Change: Understanding the Human Dimensions. The National Academic Press.
2. Hester, R.E. and Harrison, R.M. (2002). Global Environmental Change. Royal Society of Chemistry.
3. Matthew, R.A.; Barnett, J. and McDonald, B. (2009). Global Environmental Change and Human Security. MIT Press., USA.
4. Turekian, K.K. (1996). Global Environmental Change-Past, Present, and Future. Prentice-Hall.

Web resources

1. https://incois.gov.in/
2. https://mausam.imd.gov.in/
3. https://mausamjournal.imd.gov.in/index.php/MAUSAM

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO 1	Explain the impact of climate change on human wellbeing.	U	PSO-1,2
CO 2	Evaluate the means by which the impact of climate change can be reduced.	R, U	PSO-1,2
CO 3	Critically read and discuss articles related to climate or evaluate the causes of climate change, including greenhouse gases, their sources, and the greenhouse effect.	A, E	PSO-1,2
CO 4	Recognise the importance of approaches of different agencies on global warming.	E	PSO-1,2
CO 5	Explain the anthropological impact of climate change or assess the impacts of climate change on atmospheric deposition, excessive nutrient and trace element deposition, acid rain, eutrophication, and their consequences on various ecosystems and human activities.	A, E, U	PSO-1,2
CO6	Identify and discuss global environmental change issues and challenges, including the evolution of the ozone layer, radiation transfer, and an improved estimate of climate sensitivity.	A, E	PSO-1,2
CO7	Analyse future climate scenarios and projections, including cloud formation, El Niño, and its effects on climate patterns.	A	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Global Climate Change
Credits: 3:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Explain the impact of climate change on human wellbeing.	PO 1/ PSO-1,2	U	F, C	L	-
2	Evaluate the means by which the impact of climate change can be reduced.	PO 1, PO 2/ PSO1, PSO 2	R, U	F, P	L	--
3	Critically read and discuss articles related to climate or evaluate the causes of climate change, including greenhouse gases, their sources, and the greenhouse effect.	PO2/ PSO1, PSO 2	An, E	F	L	-
4	Recognise the importance of approaches of different agencies on global warming.	PO1, PO2/ PSO1, PSO 2	E	F, C	L	-
5	Explain the anthropological impact of climate change or assess the impacts of climate change on atmospheric deposition, excessive nutrient and trace element deposition, acid rain, eutrophication, and their consequences on various ecosystems and human activities.	PO1, PO2/ PSO1, PSO 2	An, E, U	F	L	-
6	Identify and discuss global environmental change issues and challenges,	PO 2/ PSO1, PSO 2	An, E	F, C	L	-

	including the evolution of the ozone layer, radiative transfer, and an improved estimate of climate sensitivity.					
7	Analyse future climate scenarios and projections, including cloud formation, El Nino, and its effects on climate patterns.	PO2/ PSO1, PSO 2	An	F, P	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**
CO 1	3	2	-	-	-	-	2	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	2	3	-	-	-	-	-
CO 3	1	1	-	-	-	-	-	1	-	-	-	-	-
CO 4	2	2	-	-	-	-	1	2	-	-	-	-	-
CO 5	3	1	-	-	-	-	3	2	-	-	-	-	-
CO 6	1	2	-	-	-	-	-	2	-	-	-	-	-
CO 7	2	1	-	-	-	-	-	3	-	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium

3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics

1. Group discussions on the pros and cons of different international agreements in climate change mitigation.
2. Global warming and Greenhouse effect
3. Ozone layer depletion
4. Acid rain and its consequences
5. Earth Hour
6. Kyoto protocol
7. Greta Thunberg
8. Paris Agreement
9. G 20
10. INCOIS and IMD

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of Green audit report
4. Submission of Activity report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6	✓	✓		✓
CO 7	✓	✓		✓

SEMESTER III

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSCZOO201**				
Course Title	**Chordate Diversity- Part I**				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	The course "Chordate Diversity Part 1" provides a comprehensive overview of chordates, from the tunicates to the amphibians. The key points covered in this course are salient features of chordates, classical classification, cladogram, and exciting examples. Exciting topics on air-breathing fishes, migratory fishes, blind fishes, endemic fishes, and invasive alien fishes are also included. Overall, the course provides a comprehensive understanding of chordate diversity and evolution. Through lectures and hands-on activities, students gain a deeper appreciation for chordates' remarkable diversity, evolutionary history, and significance in biological research and conservation efforts.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Introduction to Chordates**		**5**
	1.1	**Chordates:** Key characters (Notochord, Dorsal tubular nerve cord, Pharyngeal gill-slits) of Chordata (Brief account only).	2
	1.2	**Classification and Phylogeny:** Classical classification of chordates (Mention only). New trends in the classification of chordates based on molecular data and phylogenetic analyses (Cladogram) (Brief account only). Phylogenetic tree (Cladogram) of chordates (Brief account only).	3
II	**Non-vertebrate Chordates**		**4**
	2.1	**Non-vertebrate Chordates:** Evolutionary significance (Brief account only).	1

	2.2	**Tunicates:** General characters. Scientific classification, IUCN status, distribution, and salient features of Star tunicate (*Botryllus schlosseri*). Retrogressive metamorphosis in ascidian larvae (Brief account only).	2
	2.3	**Lancelets:** General characters. Scientific classification, IUCN status, habitat, salient features and feeding behaviour of European lancelet (*Branchiostoma lanceolatum*).	1
III		**Vertebrate Chordates**	**12**
	3.1	**Vertebrates:** An overview of evolution (Brief account only). Key characteristics and significant characteristics of vertebrates.	3
	3.2	**Fishes:** The origin of fishes (Brief account only). Key characteristics of fishes (Vertebral column, Jaws and paired appendages, Internal gills, Single-loop blood circulation, Nutritional deficiencies). Evolution of fishes (Brief account only).	3
	3.3	**Jawless Fishes (Agnathans):** General characters. Scientific classification, IUCN status, distribution, habitat, and salient features of Pacific hagfish (*Eptatretus stoutii*) and Sea lamprey (*Petromyzon marinus*) - Mention ecology, migration and invasiveness.	2
	3.4	**Cartilaginous Fishes (Chondrichthyes):** General characters. Scientific classification, IUCN status, distribution, habitat, salient features, and ecology of Spadenose shark (*Scoliodon laticaudus*) and Marbled electric ray (*Torpedo marmorata*) - Mention defence mechanism.	2
	3.5	**Bony Fishes (Osteichthyes):** General characters. Scientific classification, IUCN status, distribution, habitat, and salient features of Indian mackerel (*Rastrelliger kanagurta*) and Live sharksucker (*Echeneis naucrates)* - Mention adaptations.	2
IV		**Interesting Facts on Fishes**	**14**
	4.1	**Air-breathing Fishes:** Types of accessory respiratory organs in fishes. Brief account on accessory respiratory organs in Climbing perch (*Anabas testudineus)*, Walking catfish (*Clarias batrachus*), Spotted snakehead (*Channa punctata*), Stinging catfish (*Heteropneustes fossilis)*, European eel (*Anguilla Anguilla),* and Banded gourami (*Trichogaster fasciata).*	3
	4.2	**Fish Migration:** Mention types of migration. Classification of fishes based on migration (Anadromous and Catadromous). Significance and disadvantages of migration. Eg. Migration in European eel (*Anguilla anguilla*).	2
	4.3	**Blind Fishes:** General characteristics of cave-dwelling fishes, Threats and conservation., Very brief descriptions on the specialities of Meghalayan cave fish (*Neolissochilus pnar*), Cave goby (*Typhleotris madagascariensis*), Blind cave goby (*Typhleotris mararybe*), Blind electric ray (*Typhlonarke aysoni*), Blind catfish (*Horaglanis krishnai*), Waterfall climbing cave fish (*Cryptotora thamicola*), and Ozark cavefish (*Amblyopsis rosae*).	2
	4.5	**Common Indigenous Fishes of Kerala:** Brief descriptions on Distribution, habitat, vernacular names and threats of Denison barb/Miss Kerala (*Dawkinsia denisonii),* Gunther's catfish *(Horabagrus brachysoma),* Pearlspot (*Etroplus suratensis*).	3
	4.6	**Diversity of Invasive Alien fishes of India:** Ecological concern and effect of climate change. A case study on the invasion of the Suckermouth catfish (*Hypostomus plecostomus*). Brief descriptions of invasive alien fishes, Mozambique tilapia (*Oreochromis mossambicus*), Common carp (*Cyprinus carpio*), Striped catfish (*Pangasianodon hypophthalmus*), Orinoco sailfin catfish *(Pterygoplichthys multiradiatus),* Amazon sailfin catfish *(Pterygoplichthys pardalis),* and Pirapitinga (*Piaractus brachypomus).*	4
V		**Amphibians**	**10**

	5.1	**Amphibians:** Origin (Brief account only). Distinguishing characteristics of amphibians (Legs, Lungs, Cutaneous respiration, Pulmonary veins and Partially divided heart). Evolution of amphibians (Brief account only).	3
	5.2	**Modern Amphibians:** **Frogs and Toads (Anurans):** General characters. Scientific classification, IUCN status, habitat, and salient features. of Malabar flying frog (*Rhacophorus malabaricus*). Mention Indian toad (*Duttaphrynus parietalis)* **Salamanders (Caudatans):** General characters. Scientific classification, IUCN status, habitat, salient features, neoteny and paedogenesis of Tiger salamander (*Ambystoma tigrinum)*. Mention Neoteny. **Caecilians (Apodans):** General characters. Scientific classification, IUCN status, distribution, and salient features of Kodagu striped Ichthyophis **(***Ichthyophis kodaguensi)*.	4
	5.3	**Parental Care in Amphibians:** Types (Direct nursing & nests). Brief account of parental care in Common midwife toad (*Alytes obstetricans*), Darwin's frog (*Rhinoderma darwinii*), Common Surinam toad (*Pipa pipa*), Horned marsupial frog (*Gastrotheca cornuta)*, Malabar flying frog (*Rhacophorus malabaricus*), and Ceylon caecilian (*Ichthyophis glutinosus*).	3

References:

Recommended Books

1. Peter H. Raven, George B. Johnson, Kenneth A. Mason, Jonathan Losos, and Susan Singer, Carleton College (2017). Biology, 10th edition, McGraw Hill Education.
2. Young, J. Z. (2004). The Life of Vertebrates, 3rd Edition, Oxford University Press.
3. Michael J. Benton (2024). Vertebrate Palaeontology, 5th edition, Wiley.
4. Kotpal R. L. (2020). Vertebrates, Fifth Edition, Rastogi Publications.

Suggested Reading:

1. Darlington P. J. The geographical distribution of animals, R.E Krieger Pub Co.
2. Benton, M. J. (2004). Vertebrate Palaeontology, Third Edition. Blackwell Publishing.
3. Ueda H and Tsukamoto, K (2013). Physiology and Ecology of Fish Migration CRC Press. ISBN 9781466595132.
4. Francis Day (2018). The Fishes of India, Vol. 1: Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Forgotten Books, Reprint.
5. Francis Day (2018). The Fishes of India, Vol. 2: Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Forgotten Books, Reprint.
6. Eleonora Trajano, Maria Elina Bichuette and B.G. Kapoor (2017). Biology of Subterranean Fishes, 1st edition, CRC Press.
7. Michael J. Benton (2014). Vertebrate Palaeontology, 4th edition, Wiley-Blackwell.
8. Harvey Pough F. and Christine M. Janis (2019). Vertebrate Life, 10th Edition, Oxford University Press.
9. Richard D. Aldridge (2019). Handbook of Animal Diversity, CRC Press, ISBN 9781351089906, First Edition.
10. Kenneth Kardong (2019). Vertebrates: Comparative Anatomy, Function, Evolution. ISBN13: 9781259700910, 8th Edition.

Web Resources:

1. http://palaeo.gly.bris.ac.uk/benton/vertclass.html
2. https://www.britannica.com/animal/cave-fish
3. https://encyclopediaofarkansas.net/entries/cave-fishes-14667/
4. https://vertebrate-zoology.arphahub.com/article/101011/
5. https://epgp.inflibnet.ac.in

6. https://epgp.inflibnet.ac.in
7. https://www.britannica.com/science/invasive-species
8. https://www.fishbase.se/search.php

Practicum (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

Sl. No.	Contents
1	**Tunicates**: External organisation of an adult *Ascidia.* Sketch and label (Spotter).
2	**Lancelets:** European lancelet (*Branchiostoma lanceolatum),* Wheel organ of *Amphioxus*. Sketch and label (Spotter).
3	**Cartilaginous Fishes (Chondrichthyes):** Spotted eagle ray (*Aetobatus narinari*) and Smooth hammerhead (*Sphyrna zygaena*). Salient features (Spotter). (Use photos/drawings).
4	**Bony Fishes (Osteichthyes):** Bigeye tuna (*Thunnus obesus*), Short-snouted seahorse (*Hippocampus hippocampus*), and Oceanic two-wing flyingfish (*Exocoetus obtusirostris*)**.** Salient features (Spotter). (Use photos/drawings).
5	**Frogs and Toads (Anurans):** Purple frog (*Nasikabatrachus sahyadrensis*) and Asian common toad (*Duttaphrynus melanostictus*). Salient features (Spotter). (Use photos/drawings).
6	**Salamanders (Caudatans):** Yellow-spotted salamander (*Ambystoma maculatum*) and Proteus (*Proteus anguinus*): Salient features (Spotter). (Use photos/drawings).
7	**Caecilians (Apodans):** Taita African caecilian (*Boulengerula taitana*): Salient features. (Spotter). (Use photos/drawings).
8	**Osteology of frog**: Typical vertebra, Ninth vertebra, Urostyle. Sketch and label. (Spotter).
9	Isolation and temporary whole mount preparation of Placoid scales of Shark (Minor practical).
10	Isolation and temporary whole mount preparation of Cycloid scales of a fish (Minor practical).
11	Isolation and temporary whole mount preparation of the Ctenoid scale of a fish (Minor practical).
12	Dissection and display the digestive system of any fish (Major practical).
13	Make a poster on the phylogeny of the living vertebrates (Use photographs/drawings, Group activity).
14	Make a poster showing major classes of fishes, typical examples (photographs/drawings) and key characteristics (Group activity).

15	PowerPoint presentation on Amphibian Orders (Anura, Caudata, and Apoda). Typical examples and Key characteristics of living Amphibians (Frogs, Toads, Salamanders, Newts, and Caecilians) must be included (Group activity).
16	Visit a local aquarium and make a report on five exotic ornamental fishes (Individual report).

References

Recommended Books:

1. Peter H. Raven, George B. Johnson, Kenneth A. Mason, Jonathan Losos, and Susan Singer, Carleton College (2017). Biology, 10th edition, McGraw Hill Education.
2. Young, J. Z. (2004). The Life of Vertebrates, 3rd Edition, Oxford University Press.
3. Kotpal R. L. (2020). Vertebrates, Fifth Edition, Rastogi Publications.

Suggested Reading:

1. Francis Day (2018). The Fishes of India, Vol. 1: Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Forgotten Books, Reprint.
2. Francis Day (2018). The Fishes of India, Vol. 2: Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Forgotten Books, Reprint.
3. Harvey Pough F. and Christine M. Janis (2019). Vertebrate Life, 10th Edition, Oxford University Press.
4. Richard D. Aldridge (2019). Handbook of Animal Diversity, CRC Press, ISBN 9781351089906, First Edition.
5. Kenneth Kardong (2019). Vertebrates: Comparative Anatomy, Function, Evolution. ISBN13: 9781259700910, 8th Edition.

Web Resources:

1. https://www.britannica.com
2. https://www.fishbase.se/search.php
3. https://animaldiversity.org
4. https://cmfri.com/library-museum.html
5. https://www.museumsofindia.org/museum/12251/kerala-biodiversity-museum
6. https://tnhm.in
7. https://naturalhistory.si.edu

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain proficiency in recognizing the distinctive traits and attributes of chordates and cultivate adeptness in identifying them through practical laboratory exercises.	U, Ap, An	1, 3, 6

CO-2	Understand and analyse key distinguishing features and evolutionary significance of cephalochordates and learn food and feeding strategies through practical laboratory sessions.	U, Ap, An	1, 2, 3, 6
CO-3	Understand and analyse the salient features of Tunicates and create awareness of their habitats.	U, Ap, An	1, 3, 6
CO-4	Gain a thorough understanding of the diversity and conservation considerations related to fishes, while enhancing visualization skills through the creation of posters and hands-on laboratory experiences.	U, Ap, An	1, 3, 5, 6, 7
CO-5	Gain insight into and analyse the critical distinguishing characteristics, ecological roles, and parental care behaviours observed in amphibians.	Ap, An	3, 7, 6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Chordate Diversity -Part I

Credits: 3:0:1(Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Gain proficiency in recognizing the distinctive traits and attributes of chordates and cultivate adeptness in identifying them through practical laboratory exercises.	PO-1, 5, 6/ PSO-1, 3, 6	U, An, Ap	C, P	L	P
2	Understand and analyse key distinguishing features and evolutionary significance of cephalochordates and learn food and feeding strategies through practical laboratory sessions.	PO-1, 6/ PSO- 1, 2, 3, 6	U, An, Ap	F, C, P	L	P
3	Understand and analyse the salient features of Tunicates and create awareness of their habitats.	PO-1, 6/ PSO-1, 3, 6	U, An, Ap	F, C, P	L	P

4	Gain a thorough understanding of the diversity and conservation considerations related to fishes, while enhancing visualization skills through the creation of posters and hands-on laboratory experiences.	PO-1, 2, 5, 6, 8 /PSO-1, 3, 5, 6, 7	U, An, Ap	F, C, P	L	P
5	Gain insight into and analyse the critical distinguishing characteristics, ecological roles, and parental care behaviours observed in amphibians.	PO-1, 6, 8/ PSO-3, 6, 7	U, An, Ap	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PSO7	PSO8
1	3	-	3	-	-	1	-	-	2	-	-	-	1	1	-	-
2	-	1	3	-	-	1	-	-	1	-	-	-	-	2	-	-
3	-	-	3	-	-	1	-	-	2	-	-	-	-	2	-	-
4	-	-	2	-	2	1	1	-	2	2	-	-	2	3	-	1
5	-	-	3	-	-	1	1	-	1	-	-	-	-	3	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low
2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:

Assignments/Seminars (Any two)

1. Explore the symbiotic relationships between tunicates and other organisms.
2. Adaptations of Lancelets to benthic environments.
3. Fish diversity in freshwater ecosystems.
4. Amphibian-associated ecosystem services.

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Submission of reports
4. Submission of field reports
5. Tests

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examinations

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	✓	-	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSCZOO202**				
Course Title	**Diversity of Chordates**				
Type of Course	**DSC**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	Diversity of Chordates is an undergraduate course that leads the learner into the captivating world of chordates, with animals ranging from fish to mammals. Through engaging lectures and practical sessions, students explore the anatomical, physiological, and ecological intricacies of chordates. The course also delves into evolutionary relationships among chordate taxa, shedding light on the fascinating journey of life from primitive sea creatures to complex terrestrial vertebrates. With hands-on activities, and interactive discussions, the students gain a profound appreciation for the wonders of chordate life and their crucial roles in shaping ecosystems worldwide.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Chordate investigations – In water**	**14**
	1.1	What are chordates – Explain apomorphies	1
	1.2	Outline of Chordate classification (Use cladistic classification with study of apomorphies of each clade)	4
	1.3	Urochordata and Cephalochordata (mention examples)	2

	1.4	Agnatha - Myxinomorphi, Petromyzontomorphi	2
	1.5	Fishes – General morphology and anatomy (Overview of viscera and skeleton)	2
	1.6	Outline of fish classification, origin and evolution	1
	1.7	Common freshwater fishes *Sahyadria, Garra, Channa, Anguilla* (genus as a whole) and State fish of Kerala, National fish of India	2
II	**Into the land - Amphibians**		**7**
	2.1	Outline of amphibian classification, Apomorphies of amphibia, Origin and evolution	2
	2.2	Study of skeletal system of frogs, respiratory system	2
	2.3	Features of Gymnophiona (caecilians) with mention of Ichthyophis and Uraeotyphlus from Kerala	1
	2.4	Batrachia – Features of Anura, description of frogs and toads	1
	2.5	Batrachia – Features of Urodela, description of Indian salamander	1
III	**Conquerors of land - Reptiles**		**8**
	3.1	Outline of reptilian classification, Apomorphies of Reptiles	1
	3.2	Origin and evolution of reptiles, Brief mention of dinosaurs	1
	3.3	Squamata – Lizards: General outline of lizards and brief description of house lizards, skinks and chameleon	2
	3.4	Squamata – Snakes: Brief outline of seven families of snakes (Mention venomous snake groups in India)	2
	3.5	Brief outline of Rhynchocephalia and Crocodilia	1
	3.6	*Testudinea*: differentiate between Turtles, Tortoises and Terrapins	1
IV	**Into the air - Aves**		**7**
	4.1	Outline of avian classification, Apomorphies of Aves, Origin and evolution of birds	2
	4.2	Morphological characters of birds, feathers and plumage, Anatomy – synsacrum and syrinx	2

	4.3	Techniques in bird watching, Bird calls.	2
	4.4	Identification of 10 common birds in the locality, State bird of Kerala and National bird of India.	1
V	**Explorers of fur - Mammals**		**9**
	5.1	Outline of mammalian classification, Apomorphies of mammalia, Origin and evolution of mammals.	2
	5.2	Prototheria – brief description of Platypus and Echidnas.	1
	5.3	Theria – Metatheria, brief description of marsupials.	1
	5.4	Theria – Eutheria, Characters of placental mammals.	1
	5.5	Study of Arboreal mammals and their systematic position.	1
	5.6	Study of relationship between Sirenea and Proboscida.	1
	5.7	Study of relationship between Artiodactyla and Cetacea.	1
	5.8	Study of primates with macaques and langurs as example.	1

Practicum (30 hrs)

Sl.No.	Contents
1	Prepare a detailed note on Latimeria with images
2	Collection (geotagged photographs) and identification of 5 freshwater fishes and 5 brackish/marine fishes using taxonomic keys
3	Dissection of digestive system of any available fish
4	Extraction and identification of Placoid, ctenoid and cycloid scales
5	Identification of clades from the latest chordate tree of life.
6	Identification of vertebrae of frog
7	Differentiate between Ichthyophis and Uraeotyphlus and prepare notes. (Use specimens, if available in the museum. Else collect images or videos for identification.)

8	Identification of any one species each of house lizard and skink
9	Identification of any 4 species of snakes
10	Prepare a detailed note on any dinosaur species (include details of its discovery, museum specimens and structural recreation)
11	Identification of morphological characters of birds
12	Study of bird feathers
13	Observation and identification of minimum 10 birds in the locality and preparation of short notes.
14	Prepare a presentation on any mammal species (5 slides and submit print out)
15	Prepare a poster for the identification of any mammalian order
16	Prepare a detailed note on any 5 wild mammal species.

References

1. Vertebrate Life, 11th Edition; Harvey Pough, William E. Bemis, Betty Anne McGuire, and Christine M. Janis; Oxford University Press
2. The Diversity of Fishes: Biology, Evolution, and Ecology; Gene S. Helfman, Bruce B. Collette, Douglas E. Facey; Wiley
3. The Cornell Lab of Ornithology Handbook of Bird Biology (third edition); Irby J. Lovette and John W. Fitzpatrick; John Wiley & Sons

Web Resources

1. https://ebird.org
2. https://amazingzoology.com/latest-classification
3. https://open-education-repository.ucl.ac.uk/view/keywords/vertebrate.html

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify the systematic status of chordates from the tree of life by applying the principles of cladistics.	R, U, Ap	PSO-1,2

CO-2	Understand the origin and evolution of various chordate groups.	R, U	
CO-3	Systematically identify and place an animal under a specific chordae group.	R, U	
CO-4	Identify morphological and anatomical features of various chordates.	R, U	
CO-5	Prepare notes on the identification and description of an animal	U, An	

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Diversity of Chordates

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Identify the systematic status of chordates from the tree of life by applying the principles of cladistics.	PO-1,2,3 PSO-1, PSO-3	R, U, Ap	F, C	L	P
CO-2	Understand the origin and evolution of various chordate groups.	PO- 1,2 PSO-1	R, U	F, C	L	
CO-3	Systematically identify and place an animal under a specific chordae group.	PO -1,2 PSO-1	R, U	F, C	L	
CO-4	Identify morphological and anatomical	PO- 1,2 PSO-3	R, U	F, C	L	P

	features of various chordates.					
CO-5	Prepare notes on the identification and description of an animal	PO 1,6 PSO-1, PSO-6	U, An	F, C, P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**
CO 1	3	-	2	-	-	-	3	2	-	1	-		-
CO 2	3	-	-	-	-	-	2	1	-	-	-	-	-
CO 3	3	-	-	-	-	-	3	3	-	-	-	-	-
CO 4	-	-	3	-	-	-	3	1	-	-	-	-	-
CO 5	3	-	3	-	-	-	2	-	-	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignments

1. Migration in fishes
2. Accessory respiratory organ in fishes
3. Parental care in amphibians
4. Flight adaptations in birds
5. Aquatic adaptations in mammals

6. Dentition in mammals

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Test
4. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer questions
4. Essay Type questions

Mapping of COs to Assessment Rubrics:

	Quiz	Assignment	Presentations	Group Discussions	End Semester Examinations
CO 1	✓	✓			✓
CO 2	✓	✓		✓	✓
CO 3	✓	✓			✓
CO 4	✓	✓	✓		✓
CO 5		✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSCZOO203**				
Course Title	**Concepts of Ethology**				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course provides a detailed examination of animal behaviour, spanning its historical origins, classification, and analysis, alongside discussions on proximate and ultimate causes. Students explore a broad spectrum of topics including social dynamics, sexual behaviours, communication, territoriality, aggression, parental care, and the intricate rhythms of chronobiology, with a focus on understanding the evolutionary forces that shape these behaviours. Field oriented activities of this course will help the student a better understanding of animal and its interaction with environment.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Introduction to Animal Behaviour**	**6**
	1.1	Origin and history of Ethology, Animal behaviour classification and Analysis of behaviour patterns (Brief Account).	2
	1.2	Proximate and ultimate causes of behaviour, Methods and recording of a behaviour.	2
	1.3	Brief contributions of Karl Von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen	2
II		**Animal Behaviour Patterns**	**6**
	2.1	Patterns of Behaviour, Stereotyped Behaviours - Orientation and Reflex. Individual Behavioural patterns: Instinct and Learned Behaviour.	3
	2.2	Associative learning, classical and operant conditioning, Habituation, Imprinting (Brief).	3
III		**Social and Sexual behaviour**	**10**
	3.1	Social Behaviour: Social organization in termites and honey bees. Altruism. Conflict behaviour.	3
	3.2	Sexual Behaviour, Sexual dimorphism, Mate choice in peacock. Intra-sexual selection (male rivalry in red deer).	3

	3.3	Kinship theory: Relatedness & inclusive fitness.	2
	3.4	Parental care in fishes (Nest building & cost benefit)	2
IV	**Behaviour and Evolution of Behaviours**		**11**
	4.1	Behaviour and evolution of communication in animals: Social communication; Social dominance, Communication in honey bee	4
	4.2	Territoriality in Monkeys and Dogs, mating systems, parental investment and reproductive success.	3
	4.3	Aggressive behavior, Parental care, habitat selection and optimality in foraging	4
V	**Chronobiology**		**12**
	5.1	Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod regulation seasonal reproduction of vertebrates; Role of melatonin.	4
	5.2	Migration, orientation and navigation; Domestication and behavioural changes. Biological rhythms: types and characteristics	4
	5.3	Chronobiology; Brief historical developments in chronobiology; Adaptive significance of biological clocks; Relevance of biological clocks; Describe briefly: Chronopharmacology, Chronomedicine, Chronotherapy.	4

Practicum (30 hrs)

Sl.No.	Contents
1	To study nests and nesting habits of the birds and social insects.
2	To study the behavioural responses of wood lice to dry and humid conditions.
3	To study geotaxis behaviour in earthworm/ To study the phototaxis behaviour in insect larvae.
4	Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a project report.
5	Study of circadian functions in humans (daily eating, sleep and temperature patterns)

References

1. Ridley, M (2004). Evolution III Edition Blackwell publishing.
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
3. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
4. V. B Rastogi (2018) Organic Evolution- MEDTEC publication.
5. Ridley, M (2004) Evolution III Edition Blackwell publishing.
6. David McFarland (1985).Animal Behaviour, Pitman Publishing Limited, London, UK.
7. Manning, A. and Dawkins, M. S (2012). An Introduction to Animal Behaviour, Cambridge, University Press, UK.

8. Drickamar (2001). Animal Behavior: Mechanisms, Ecology, Evolution. McGraw-Hill
9. Education.
10. John Alcock (2001). Animal Behaviour, Sinauer Associate Inc., USA.
11. Paul W. Sherman and John Alcock (2010) Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
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Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Examine and critically to evaluate the emergence of ideas that have shaped how we observe and collect data on animal behaviour.	U, An	PSO-1,2
CO-2	Imagine and improve the beneficiaries attitude to monitor the animal responses using suitable activity	C,R,U	PSO-1,2
CO-3	Understand the main historical ideas that underpin animal behaviour theory	R, U	PSO-2,3
CO-4	Critically review hypotheses to explain evolution of animal behaviour	U, An	PSO-1,2
CO-5	Understand and identify different biological rhythms in animal life	A, E, C	PSO-1,5,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Concepts of Ethology

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Examine and critically to evaluate the emergence of ideas that have shaped how we observe and collect data on animal behaviour.	PO-1/PSO-1/PSO-2	U, An	F	L	
2	Imagine and improve the beneficiaries attitude to monitor the animal responses using suitable activity	PO-1/PSO-1,2	C,R,U	F,C	L	P
3	Understand the main historical ideas that underpin animal behaviour theory	PO-5/PO-8/PSO-2/PSO-3	R, U	F, C	L	
4	Critically review hypotheses to explain animal behaviour	PO-8/PSO-1/PSO-2	An	F, C	L	
5	Understand different methods for collecting data on animal	PO-6/PO-8/PSO-1/PSO-	A, C	P		P

	behaviour	5/PSO-6				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	2	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO2	1	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO3	-	2	3	-	-	-	-	-	-	-	-	-	3	-	-	2
CO4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO5	2	-	-	-	2	2	-	-	-	-	-	-	-	2	-	3

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment /Seminar Topics

- Animal Behavioural Types
- Animal Migration
- Biological Clocks
- Biological Rhythms
- Chronobiology

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSCZOO204**				
Course Title	**Body Functions and Regulation**				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 – 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	hours	4
Pre-requisites	Pass in Class XII				
Course Summary	Through the course, the student shall gain knowledge and can explore the research findings, case studies, and interdisciplinary perspectives to deepen their understanding of how physiological processes shape human behaviour. By integrating knowledge from neuroscience, endocrinology, and psychology, students gain a comprehensive understanding of the physiological basis of behaviour and its implications for health and well-being.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I	**Eating and its regulation**		**10**
	1.1	Set point theories of hunger and eating: thermostatic theory, lipostatic theory and glucostatic theory	2
	1.2	Feeding centres in the brain- hypothalamus, hunger and satiety centres**,** arcuate nucleus, paraventricular nucleus, orexigenic and anorexigenic signals, orbitofrontal cortex, peripheral factors- ghrelin, insulin, leptin, nesfatin-1 and cholecystokinin	5

	1.3	Eating disorders: obesity (BMI, causes and management), brief account on polyphagia, aphagia, anorexia nervosa and bulimia nervosa	3
	Related activities: 1. *Survey based on the identification of obese people (group activity).* *2.Conduct awareness programmes through role play/group discussion related to nutritional components and their physiological role.*		
II	**Physiological basis of drinking**		**8**
	2.1	Water gain and loss in human body, thirst- osmotic thirst and hypovolemic thirst Regulation of thirst: thirst receptors, renin angiotensin system, hypothalamic control of thirst, anticipatory signals	5
	2.2	Disorders of water balance: dehydration, fluid sequestration, polydipsia, adipsia	3
III	**Sleep and dreaming**		**12**
	3.1	Stages of sleep and changes in EEG, NREM sleep, REM sleep and dreaming, functions of sleep	5
	3.2	Neural control of sleep – ARAS, brain stem nuclei, noradrenergic systems, serotonergic systems, cholinergic systems, reciprocal interaction model of sleep, role of hypothalamus	4
	3.3	Sleep disorders: insomnia, narcolepsy, sleep apnea, somnambulism, jet lag	3
	Related activity: *Identify people suffering from sleep disorders and provide advice for remedies by survey method.*		
IV	**Sexual behaviour**		**11**
	4.1	Definition of sex, dynamics of sexual behaviour- mating patterns based on number of mates and breeding period, external control of sexual behaviour- Coolidge effect; external cues	6
	4.2	Neural mechanisms of sexual behaviour- brain and sexual behaviour performance circuit, role of hypothalamus, pituitary and gonads- control of the secretion of sex hormones in male and female, role of pheromones	4
	4.3.	Chemical interventions and sexual behaviour – chemicals that target dopamine, serotonin, sexual orientation	1
	Related activity: *Conduct invited talks/power point presentation by students focusing on sexuality development and behaviour.*		
V		**Learning and memory**	**19**

	5.1	Learning – definition and types of learning- motor, verbal, concept, discrimination, principles of learning- problem solving, attitude learning	4
	5.2	Early learning discoveries – Pavlov's experiments, Lashley's work, Thompson's work, learning outside hippocampus	4
	5.3	Criteria of memory, types of memory- declarative/explicit, non-declarative/implicit, semantic and episodic memories, long term and short term memories Brain regions involved in learning and memory	5
	5.4	Neural mechanisms of memory: synaptic plasticity, Hebbian synapses, long term potentiation (LTP), hippocampus and glutamate receptors, engram	4
	5.5	Forgetting: theories of forgetting- interference theory, retrieval theory, weak storage theory.	2
	Related activities: 1. *Invited talks by neurologists/psychologists focusing on memory retention.* *2.Intraclass competition to find memory power among learners using randomly ordered words/items.*		

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Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Comprehensive understanding of the neurobiological, physiological, and behavioral factors that influence feeding behavior, digestion, and body weight	U, An	PSO-1,2

	regulation. They will also gain insight into the causes, consequences, and management strategies for obesity, a major public health concern.		
CO-2	By achieving these learning outcomes, students will develop a comprehensive understanding of the neurobiological mechanisms underlying thirst regulation and drinking behavior. They will also gain insight into the physiological components, neural pathways, and feedback mechanisms involved in maintaining fluid balance and osmotic equilibrium in the body.	R, U	PSO-1, 2.3.4
CO-3	Understand the biological mechanisms underlying sleep and wakefulness, as well as the significance of circadian rhythms in regulating physiological and cognitive processes.	R, U	PSO-2,4
CO-4	Students will develop a comprehensive understanding of human sexuality, including biological, psychological, social, and cultural aspects. They will also gain insight into the factors influencing sexual development, behavior, and reproduction across the lifespan.	U, E	PSO-1,2,4
CO 5	Understanding these concepts provides insights into how we learn, remember, and adapt to our environment, forming the foundation of cognitive psychology and neuroscience.	An, E	PSO-2,4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Body Functions and Regulation

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	Comprehensive understanding of the neurobiological, physiological, and behavioral factors that influence	PO-1, PO-2/PSO-1,2,4	U, An	F, C	L	

	feeding behavior, digestion, and body weight regulation. They will also gain insight into the causes, consequences, and management strategies for obesity, a major public health concern.					
2	By achieving these learning outcomes, students will develop a comprehensive understanding of the neurobiological mechanisms underlying thirst regulation and drinking behavior. They will also gain insight into the physiological components, neural pathways, and feedback mechanisms involved in maintaining fluid balance and osmotic equilibrium in the body.	PO-1,2/PSO-1,2,3,4	R, U	F,C	L	
3	Understand the biological mechanisms underlying sleep and wakefulness, as well as the significance of circadian rhythms	PO-2,4/PSO-2,4	R, U	F,C	L	

	in regulating physiological and cognitive processes.					
4	Students will develop a comprehensive understanding of human sexuality, including biological, psychological, social, and cultural aspects. They will also gain insight into the factors influencing sexual development, behavior, and reproduction across the lifespan.	PO-2,4/PSO-1,2,4	U, E	F, C	L	
5	Understanding these concepts provides insights into how we learn, remember, and adapt to our environment, forming the foundation of cognitive psychology and neuroscience.	PO-4,5/PSO-2,4	An, E	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	2	2	-	1	-	-	-	-	2	2	-	-	-	-	-	-

CO 2	1	2	2	2	-	-	-	-	2	2	-	-	-	-	-	-
CO 3	-	2	-	2	-	-	-	-	-	2	-	2	-	-	-	-
CO 4	2	2	-	3	-	-	-	-	-	2	-	2	-	-	-	-
CO 5	-	2	-	3	-	-	-	-	-	2	-	2	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ seminar topics

1. Labelled diagram of the human brain regions involved in feeding
2. Diagrammatic representation of interactions of various components of feeding
3. Age related difference in sleep
4. Water retention and body functions
5. Sleep and changes in EEG
6. Memory and ageing

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Test
4. Model preparation

End Semester evaluation

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Essay type questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSCZOO205**				
Course Title	**Human Parasitology and Vector- Borne Diseases**				
Type of Course	**DSC**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This undergraduate course provides students with a comprehensive understanding of human parasitology and vector-borne diseases. Through lectures, laboratory sessions, and fieldwork, students will explore the fundamental concepts, epidemiology, transmission, and control strategies related to various parasitic organisms and vector-borne diseases affecting human populations.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Introduction to Parasitology and Vector Biology**	**10**
	1.1	Overview of human parasites and vectors – Introduction, definition of terms – parasites, host, carriers, parasitism, Importance of studying parasitic and vector borne diseases	2
	1.2	Types of parasites – Permanent &Temporary, Facultative & Obligate, Zoophilic & Anthropophilic, Ectoparasites and Endoparasites, Monogenetic & Digenetic - definition and 1 example each	2

	1.3	Classification of human parasites – Protozoa and Metazoa (Helminths and Arthropods) Helminths - Platyhelminthes (Trematoda and Cestoda) and Nematoda Arthropoda – Arachnida, Insecta	2
	1.4	Types of vectors – Biological (Active) and Mechanical (Passive)– definition and 2 examples each	1
	1.5	Classification of vectors – Arthropoda, Mollusca and Mammalia – One example each	1
	1.6	Host-parasite interactions – parasitism, commensalism and mutualism Host- vector interactions	2
II	**Basic Concepts in Parasite Biology**		**10**
	2.1	Morphological characteristics and Taxonomic classification of common human parasites *–Plasmodium vivax, Entamoeba histolytica, Schistosoma haematobium, Taenia solium, Ascaris lumbricoides, Ancylostoma duodenale and Wuchereria Bancrofti*	3
	2.2	Parasite life cycles – direct vs. indirect transmission, host specificity and host range, modes of transmission – waterborne (mention example *E. histolytica*), foodborne (mention example *T. solium*), vector-borne (mention example *P. vivax*) and zoonotic transmission (mention example *Toxoplasma. gondii*)	2
	2.3	Epidemiology of Parasitic diseases – global distribution, factors influencing disease transmission – environmental, socioeconomic and behavioral factors; Impact of climate change and urbanization on disease epidemiology	3
	2.4	Host-Parasite Interactions – Overview of host immune responses to parasitic infections, mechanisms of evasion of host immunity	2
III	**Human Parasitic Diseases**		**12**
	3.1	Protozoan parasites: Morphology, life cycles, and pathogenesis – *Plasmodium vivax, Entamoeba histolytica*. Add notes on clinical manifestations/symptoms, treatment and prophylaxis.	4
	3.2	Helminthic parasites: Morphology (emphasis on parasitic adaptations), life cycles, and pathogenesis – *Schistosoma haematobium, Taenia solium.* Add notes on clinical manifestations/symptoms, treatment and prophylaxis.	4
	3.3	Human Nematode parasites: Morphology (emphasis on parasitic adaptations), life cycles, and pathogenesis – *Ascaris lumbricoides, Ancylostoma duodenale and Wuchereria bancrofti.* Add notes on clinical manifestations/symptoms, treatment and prophylaxis.	4

IV	**Introduction to Vector-borne diseases**		**8**
	4.1	Introduction to vector-borne diseases and overview of vectors- mosquitoes, ticks, flies	2
	4.2	Major vector-borne diseases: malaria, dengue fever, Zika, Lyme disease and rat fever -Pathogenesis and clinical manifestations, treatment, and prophylaxis	4
	4.3	Public health implications and vector control measures (insecticide-treated bed nets, indoor residual spraying)	2
V	**The Importance and Future of Parasitology**		**5**
	5.1	Importance of studying human parasitology and vector biology – impact on vulnerable populations	1
	5.2	Ethical and social considerations – ethical issues related to research on human parasitic diseases; social determinants – transmission and access to healthcare	1
	5.3	The future of parasitology – Vaccine development and implementation, targeted therapy, vector control and surveillance, career opportunities (research scientist, public health specialist, vector control specialist, medical entomologist, epidemiologist, academic educator, consultant, wildlife biologist, pharmaceutical/biotechnology industry professional	2
	5.4	Indian Institutes specializing in Parasitology and Vector-borne diseases – NIMR (New Delhi), NIE (Chennai), NIV (Pune), VCRC (Puducherry), RMRC (Dibrugarh), ICMR-NITM (Belagavi), IIPH (Gandhinagar), NCDC (Delhi) – mention their role/contribution	1

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Practicum (30 hrs)

Sl. No.	Contents
1.	Study of Plasm*odium vivax, Entamoeba histolytica*, and their life stages through permanent slides/photomicrographs or specimens.
2.	Study of adult *Schistosoma haematobium, Taenia solium* and their parasitic adaptations (Slides/microphotographs)
3.	Study of adult *Ascaris lumbricoides, Wuchereria bancrofti* and their parasitic adaptations (Slides/micro-photographs)

4.	Study of arthropod vectors associated with human diseases through permanent slides/ photographs: *Pediculus, Culex, Anopheles, Aedes, Musca domestica*
5.	Mounting and dissection: Mouth parts of mosquito and housefly.
6.	Submission of a report based on survey of selected localities about any one of the insect vectors and disease transmitted

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Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	**Identify and classify common parasites and vectors**: Students will demonstrate the ability to recognize and classify various parasites and vectors based on their morphological characteristics and taxonomic classification.	U	PSO-1,2
CO-2	**Understand the transmission dynamics of parasitic diseases**: Students will grasp the complex life cycles and transmission mechanisms of parasites and vectors, including the factors influencing their transmission dynamics and epidemiology.	R, U	PSO-1,2,5
CO-3	**Analyze the clinical manifestations and pathogenesis of parasitic infections**: Students will be able to analyze the clinical manifestations, pathogenesis, and impact of parasitic infections on human health, as well as understand the principles of diagnosis, treatment, and prevention.	U, A	PSO3,6

CO-4	**Evaluate vector control strategies and public health interventions**: Students will evaluate the effectiveness of different vector control strategies and public health interventions in mitigating the spread of vector-borne diseases and reducing the burden of parasitic infections on affected populations.	Ap, E	PSO3
CO-5	**Critically assess the global impact of parasitic diseases**: Students will critically evaluate the global impact of parasitic diseases on public health, socio-economic development, and environmental sustainability, as well as analyze the ethical and social dimensions of addressing parasitic infections in diverse contexts.	A, E	PSO3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Human Parasitology and Vector Borne Diseases

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
CO-1	Identify and classify common parasites and vectors: Students will demonstrate the ability to recognize and classify various parasites and vectors based on their morphological characteristics and taxonomic classification.	PSO-1,2 PO-6	U	F, C	L	P
CO-2	Understand the transmission dynamics of	PSO-1,2,5	R, U	F, P	L	P

	parasitic diseases: Students will grasp the complex life cycles and transmission mechanisms of parasites and vectors, including the factors influencing their transmission dynamics and epidemiology.					
CO-3	Analyze the clinical manifestations and pathogenesis of parasitic infections: Students will be able to analyze the clinical manifestations, pathogenesis, and impact of parasitic infections on human health, as well as understand the principles of diagnosis, treatment, and prevention.	PSO3,6	U, A	F,C,P	L	P
CO-4	Evaluate vector control strategies and public health	PSO3	Ap, E	F,C	L	

	interventions: Students will evaluate the effectiveness of different vector control strategies and public health interventions in mitigating the spread of vector-borne diseases and reducing the burden of parasitic infections on affected populations.					
CO-5	Critically assess the global impact of parasitic diseases: Students will critically evaluate the global impact of parasitic diseases on public health, socio-economic development, and environmental sustainability, as well as analyze the ethical and social dimensions of addressing parasitic infections in	PSO3 PO6	A, E		L	

	diverse contexts.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO** 7	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	2	3	-	-	-	-	-	1	1	-	-	-	3	-	-
CO 2	2	3	-	-	3	-	-	-	-	2	-	-	-	-	-
CO 3	-	-	2	-	-	2	-	-	-	-	-	2	-	-	-
CO 4	-	-	2	-	-	-	-	-	-	-	3	-	-	-	-
CO 5	-	2	-	-	-	-	-	-	2	-	2	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/Seminar Topics:

1. Socio-economic and environmental factors influencing parasitic infections
2. Emerging and Re-emerging Parasitic Diseases
3. Global Climate Change and Vector-Borne Disease Emergence

4. Neglected, Tropical and Vector Borne Diseases
5. Impact of protozoan infections on public health in India
6. One Health approach to helminthic disease control in India

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of Field/Project/Survey Report
4. Test

End Semester Exam

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Field Report/Survey Report/Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓	✓	✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSEZOO201**				
Course Title	**Fisheries Science I-Taxonomy and Fishery Biology**				
Type of Course	**DSE**				
Semester	III				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	The course provides basic understanding about the taxonomy and biology of finfishes and shellfishes to undertake any aquaculture operation. Conventional and modern methods employed for identification of species are discussed in the first module. In the subsequent modules, biological aspects pertaining to food and feeding, reproductive biology, early life history and age and growth are discussed.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Taxonomy of finfishes and shellfishes**	**12**
	1.1	Taxonomic procedures: Collection, identification and preservation of Commercially important fishes, crustaceans, and Mollusc with special reference to the fauna of Kerala.	5
	1.3	Morphological features and characters used in identification of fishes, prawns, shrimps, crabs, lobsters, and molluscs (Truss morphometry).	7
	1.4	Modern taxonomical tools: Karyotyping, DNA barcoding	2
		Food and feeding behaviour	**6**

II	2.1	Food and feeding habits of fishes, commercially important Crustaceans, and Molluscs. Feeding adaptation, Feeding in relation to Season, Growth, Sex and Breeding in Fishes, commercially important Crustaceans and Molluscs.	3
	2.2	Methods of studying Food and Feeding habit: Stomach fullness Index, Empty Stomach Ratio, Relative Gut Length, Gastro Somatic Index.	3
III		**Reproductive Biology**	**11**
	3.1	Anatomy of gonads, modes of reproduction – gonochorism, hermaphroditism, protandry, protogyny. semelparity, iteroparity.	3
	3.2	Reproductive strategies – oviparity, viviparity and ovoviviparity. Stages of maturity in finfishes and shellfishes. Factors influencing reproduction.	3
	3.3	Maturation and Spawning in Fishes: Methods used to estimate size at maturity, sex ratio, spawning season, spawning frequency, Fecundity, Gonadosomatic index.	3
	3.4	Fecundity and its relationship to reproductive adaptation, Environmental influence of Fecundity.	2
IV		**Early life history**	**10**
	4.1	Types of eggs, embryonic and larval development in finfishes. Hatching rate, survival rate and mortality rate, free embryo, critical period concept.	4
	4.2	Early developmental stages of shrimps, crabs, lobsters and bivalves (brief account only)	5
	4.3	Parental care in fishes	1
V		**Age and Growth**	**6**
	5.1	Age determination – Methods employed in age determination, tagging recapture technique, chemical markers, Petersen method, examination of hard parts	4
	5.2	Factors affecting fish growth, Length-weight relationship, isometric and allometric growth, Condition Factor and Relative condition factor.	2

References:

1. Bal, D.V. and K.V. Rao, 1990. Marine fisheries of India. Tata McGraw-Hill Publishing Company Limited, New Delhi. First revised edition. 472 pp.
2. Bone, Q and R.H. Moore. 2008 (Third Ed.). Biology of fishes. Taylor & Francis Group, New York.
3. Biswas, K.P. 1996. A Textbook of Fish, Fisheries and Technology. 2nd ed. Narendra Publ. Hse., India
4. Bone,Q., N. B. Marshall and J.H.S. Blaxter.1999. Biology of Fishes. Chapmann and Hall

5. Carpenter KE & VH Niem (1998) FAO Species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vol 1. Seaweeds, corals, bivalves and gastropods. FAO, Rome.
6. Clark, A.B. & A.L. Panchen 1974. Synopsis of Animal Classification. John Wiley & Sons Inc., NY.
7.Cowey, C.B. et al. 1985. Nutrition and Feeding in Fish. Academic Press, New York
8. Datta Munshi, J.S & M.P. Srivastava 1988. Natural History of Fishes: Systematics of Freshwater Fishes of India. Narendra Publishing Co., New Delhi, 403 pp.
9. Day, F. 1865. The Fishes of Malabar. Quariteb, London, 293 pp.
10. Halver, J.E. 1972. Fish Nutrition. Academic Press, London.
11. Hewitt, G. M., A. W. B. Johnston, and P. R. W. Young, eds. 1991. Molecular Techniques in Taxonomy. Springer-Verlag, Berlin.
12. Hillis, D. M., C. Moritz, and B. K. Mable. 1996. Molecular Systematics, 2d ed. Sinauer Associates, Sunderland, Mass.
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15. Jayaram, K.C. 1999. The Freshwater Fishes of the Indian Region. Narendra Publ. Hse., Delhi, 551 pp.
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19. Lagler, K.F., J.E. Bardach & R.E. Miller 1963. Ichthyology. John Wiley & Sons, Inc., NY.
20.Moyle, P.B. and J.J. Cech, 1996. Fishes, an introduction to ichthyology. (3rd Ed.). Prentice Hall, Upper Saddle River, New Jersey, 590 pp.
21. Narendran, T.C. 2006. An Introduction to Taxonomy. Zoological Survey of India, Koltata.
22. New & Barnard. 2010. Freshwater Prawns Biology & Farming. Wiley- Blackwell, London.
23. Raghunath, M.R. 2013. Nutrition and Feeding of Fishes. Swastik Publishing House, Delhi.
24. Simpson, G.G.1969. Principles of Animal Taxonomy. Oxford & IBH Publ. Co., Bombay.
25. Smyth & Lynwood. 2003. Introduction to Fish Physiology. Narendra Publishing House, Delhi
26. Srivastava, C.B.L. 2008. Fish Biology. Narendra Publ. Hse., India, 329
27. Subba Rao, N.V. 2003. Indian Seashells: Part-I: Polyplacophora and Gastropoda. Zoological Survey of India, Kolkata.
28. Surendra Nath. 2002. Food, Feed29.abits and Alimentary canal of fishes. Vinod Publishers and Distributors, India
29. Talwar, P.K. & V.G. Jhingran 1991. Inland Fishes of India and Adjacent Countries. Vol. 2. Oxford & IBH Publ. Co., New Delhi.
30. Talwar, P.K. & R.K. Kacker 1984. Commercial Sea Fishes of India. Zoological Survey of India, Kokata, 986 pp.

Web Resources:

https://www.fao.org/fishery/en
https://www.fishbase.se/
https://indiabiodiversity.org/
http://eprints.cmfri.org.in/
https://www.fisheries.noaa.gov/
http://www.seafdec.org/#

e-Krishi Shiksha (iasri.res.in)

Practicum (30 hrs)

Sl. No	Contents
1	Identification of fishes (2) and prawns (2) using standard keys
2	Study of external morphology of fishes and prawns
3.	Study of anatomical variations in digestive system of fish – herbivore, omnivore and carnivore
4.	Gut content analysis – Occurrence/ Numerical/ Gravimetric method (any one)
5.	Estimation of Gastro somatic Index
6.	Male and female reproductive system in teleost
7.	Estimation of fecundity and gonadosomatic index in fish
8.	Study of larval stages of shellfishes – nauplius, protozoea, mysis, zoea, megalopa, phyllosoma, puerulus, trochophore, veliger (Any five-representing prawn, crab, lobster, and bivalve)
9.	Length weight relationship and condition factor of finfish

References:

1. Day, F. 1878. Fishes of India, Vols. 1 & 2. William Dawson & Sons Ltd., London.
2. Evans, D.H. 1998. The Physiology of Fishes. 2nd ed. CRC Press, NY
3. Jayaram, K.C. 2002. Fundamentals of Fish Taxonomy. Narendra Publ. Co., Delhi.
4. Khanna, S.S. & H.R. Singh 2006. A Textbook of Fish Biology and Fisheries. Narendra Publ. Hse., India
5. Kurian, C.V. & V.O. Sebastian 2002. Prawns and Prawn Fisheries of India. Revised and Edited Fifth Edition by K. Gopakumar & V.N. Pillai. Hindustan, New Delhi.
6. Nelson, J.S. 2006. (4th Ed.). Fishes of the World. John Wiley & Sons, Inc., New Jersey.
7. Jhingran, V.G (1997).Fish and Fisheries of India, Third Edition. Hindustan Publishing Corporation India.
8. Winston, J.E. 1999. Describing species. Practical Taxonomic Procedure for Biologists. Columbia University Press, New York

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO1	Understand concepts of taxonomy, conventional and modern methods used for the identification of finfishes and shellfishes	R, U, Ap	PSO-1,7

CO2	Understand the diversity of feeding and analyse food and feeding habits using gut contents and indices	U, Ap, An, Ev	PSO-2, 3
CO3	Familiarise modes and strategies of reproduction and methods to assess reproductive parameters in fishes	U, Ap, An, Ev	PSO-1,3
CO4	Understand the development and early life history of cultivable important species	U, Ap, An	PSO-4
CO5	Evaluate growth patterns and determine age of cultivable species	U, Ap, E	PSO-1,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Fisheries Science I-Taxonomy and Fishery Biology

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	Understand concepts of taxonomy, conventional and modern methods used for the identification of finfishes and shellfishes	PO-1,2,5 PSO-1,7	R, U, Ap	F,C	L	P
2	Understand the diversity of feeding and analyse food and feeding habits using gut contents and indices	PO-1,3,4,5 PSO-2, 3	U, Ap, An, Ev	F,P	L	P
	Familiarise modes and strategies of	PO-				

3	reproduction and methods to assess reproductive parameters in fishes	1,2,4,5 PSO-1,3	U, Ap, An, Ev	P	L	P
4	Understand the development and early life history of cultivable important species	PO-7,8 PSO-4	U, Ap, An	F,P	L	P
5	Evaluate growth patterns and determine age of cultivable species	PO-1,2,4,6 PSO-1,3	U, Ap, E		L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO 1	1	-	-	-	-	-						
CO 2	2	3	-	-	-	-						
CO 3	-	-	1	-	-	-						
CO 4	-	-	2	3	-	-						
CO 5	-	1	-	-	-	-						

CO 6	-	-	-	3	-	-						

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment / Seminar topics

1. Collect and identify cultivable species of fishes from your locality
2. Molecular methods in taxonomy
3. Food and feeding of common cultivable species
4. Physiology of digestion in fishes
5. Sex reversal in fishes
6. Impact of climate change in fish biology

Field activities

• Visit to harbours/ landing centres to collect and submission of commercially important finfishes and shellfishes

Continuous comprehensive Assessment

1. Assignment/ Quiz/ Discussion / Seminar
2. Submission of specimen collection report
3. Submission of Field report

End semester Evaluation

1. Very short answer questions
2. Short answer questions
3. Essay type questions
4. Practical examinations

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations

CO 1	✓	✓		✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSEZOO202**				
Course Title	**Entomology I- General Entomology**				
Type of Course	**DSE**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in class XII				
Course Summary	The course on General Entomology provides an understanding on the nature and scope of Entomology and diversity of insects that empower the students to identify the various insects around them and appreciate the diversity of the insect world. They get an understanding of morphological and anatomical features of insects. They understand basic physiological activities going on in insects. This course provides students with essential skills in handling and dissecting insects. Students understand the social life in insects and the different means of communication adopted by insects. Students become enthusiastic about the insects and their mode of living.				

Detailed syllabus

Module	Unit	Content	45 hrs
I		**Insect Diversity**	**10**
	1.1	Nature and scope of Entomology - Economic importance of insects.	2
	1.2	Classification of insects up to order (Brief description of important characters of each order with one example).	6
	1.3	Collection, preservation and culture techniques of insects.	2
		Morphology of Insects	**10**

II	2.1	Head – Mouthparts in insects (Cockroach, Honey bee). Structure of antenna, Compound eye and mosaic vision.	5
	2.2	Thorax – Wing, its modification and venation, Structure of thoracic leg, Types of legs adapted to diverse habitat.	4
	2.3	Abdomen – Segmentation, Genitalia in male and female.	1
III	**Anatomy and Physiology of Insects**		**13**
	3.1	Nutrition – Structure of gut and associated glands.	3
	3.2	Respiration – Spiracles, trachea, tracheoles and air sacs. Respiration in insects.	2
	3.3	Excretion – Malpighian tubules – structure and functioning, Accessory excretory organs (fat body, uricose glands, nephrocytes)	2
	3.4	Circulation – Dorsal vessel and accessory pumping sinuses. Composition of haemolymph.	2
	3.5	Nervous system - Structure and function	2
	3.6	Insect endocrine system – Brain neurosecretory cells, Corpora cardiaca, Corpora allata and Prothoracic gland.	2
IV	**Reproduction and Development in Insects**		**6**
	4.1	Male reproductive system and associated glands, Female reproductive system and associated glands.	2
	4.2	Metamorphosis – types and hormonal control.	2
	4.3	Moulting and Diapause	2
V	**Insect behaviour**		**6**
	5.1	Social organisation with reference to Honey bee and Termite.	3
	5.2	Communication in insects – Round dance and wagtail dance. Role of pheromones, kairomones and allomones.	3

References

1. Mani M S (1982). A general textbook of Entomology. Oxford and IBM. New Delhi.
2. Chapman, R.F. The Insects- Structure and function, ELBS Arnold.
3. Modern Entomology, DB Tembhare.
4. Wigglesworth, VB. The principles of insect physiology &LBs, Methemen and Co.Ltd
5. General & Applied entomology, KK Nayar et al.
6.Ananthakrishnan TN (1998). Dimensions of insect plant interactions. Oxford and IBH Pub.Co. Pvt.N.Delhi.
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8. Imms A D, Richard and Davies: A general textbook of Entomology. Chapman and Hall.

9. Snodgrass, R. E. Principles of insect morphology. Cornell Univ. Press, USA
10. Gullan, P. J. And Cranston, P. S. The insects, An outline of Entomology. Wiley Blackwell, UK.
11. Nation, J. L. Insect Physiology and Biochemistry. CRC Press, USA

Web Resources

1. Indian Entomologist https://www.indianentomologist.org
2. Indian Journal of Entomology https://www.indianentomology.org
3. Entomological Society of India https:// entosocindia.org
4. ICAR-Indian agricultural research institute https://www.iari.res.in>introduction
5. https://guides.library.cornell.edu/entomology
6 https://guides.uflib.ufl.edu/entomology
7. https://feedly.com>top>entomology
8. https://science.feedspot.com>entomology

Practicum (30hrs)

Sl. No	Contents
1	Mounting and display of mouthparts – Cockroach/ Honey bee/ Butter fly/ Mosquito (any 2)
2	Mounting, Sketching and labelling of antenna in Cockroach/ Honey bee/ Butter fly/ Mosquito (any 2)
3	Dissection and display of alimentary canal and associated glands - Cockroach/ Dysdercus (any 1)
4	Dissection and display of nervous system - Cockroach/ Dysdercus (any 1)
5.	Dissection and display of female reproductive system in Cockroach.
6	Morphological study of various castes of Honey bee/ Termite.
7	Setting up of the Berlese funnel and description of its principle.
8.	Field study on harmful insects and report submission on any 4 common pests.

References

1. Mani M S(1982). A general textbook of Entomology. Oxford and IBM. New Delhi.
2. General & Applied entomology, KK Nayar et al.
3. Imms A D, Richard and Davies: A general textbook of Entomology. Chapman and Hall.

Web Resources

1. https://guides.library.cornell.edu/entomology

2. https://guides.uflib.ufl.edu/entomology

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand about nature and scope of Entomology, diversity of insect world and recollect various insects met with the day today life.	U, R	PSO-1,3
CO-2	Understand the structural peculiarities of insect head, thorax and abdomen.	U, R	PSO-1,3,6
CO3	Create an insight into the various organ systems in insects and basic physiological activities going on in insects.	U, An	PSO- 4,6
CO4	Understand the structure of the reproductive system in insects and remember about the process of metamorphosis and moulting.	U, R	PSO-1,2
CO5	Remember and analyse the social organisation in insects and appreciate the communication methods in insects.	R, An	PSO-2, 4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Entomology I- General Entomology
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Understand about nature and scope of Entomology, diversity of insect world and recollect various insects met with the day today life.	PO– 1,2 PSO-1,3	U,R	F,	L	P
2.	Understand the structural peculiarities of	PO - 1	R,U	F,P	L	P

	insect head, thorax and abdomen.	PSO-1,3,6				
3.	Create an insight into the various organ systems in insects and basic physiological activities going on in insects.	PO -1,6 PSO-4,6	U, An	F, P	L	P
4.	Understand the structure of reproductive system in insects and remember about the process of metamorphosis and moulting.	PO -1,2 PSO-1,2	U,R	F,C	L	
5.	Remember and analyse the social organisation in insects and appreciate the communication methods in insects.	PO-1,2,4 PSO-2,4	R,An	F,C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PSO 7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	1	-	2	-	-	-		1	2-	-	-	-	-		
CO 2	1	-	2	-	-	3		2			-	-			
CO 3			-	1	-	2		1			-	-	2		
CO 4	1	2			-	-		1	3						
CO 5	-	1	-	2				2	2		3				

Correlation Levels:

Level	**Correlation**
-	Nil

1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics

1.Social organisation in Honey bee/ Termite/ Ants.
2. Communication in insects.
3. Mouth parts in insects.
4. Types of metamorphosis.
5. Role of microbiota in insect digestion.
6. Economic importance of insects.
7. Identification of common pests.

Continuous Comprehensive Assessment

1. Quiz
2. Assignment
3. Internal exam
4. Field report

End Semester assessment

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Essay questions
5. Practical examination

Mapping of COs to Assessment

	Internal Exam	Assignment/Quiz	Project Evaluation	End Semester Examinations
CO 1		✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3DSEZOO203**				
Course Title	**Environmental Science I- Global Environmental issues**				
Type of Course	**DSE**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in Class XII				
Course Summary	The course on Global Environmental Issues provides a comprehensive overview of the significant environmental challenges facing the planet today. It examines the complex interactions between human activities and the natural environment, focusing on climate change, biodiversity loss, pollution, resource depletion, and habitat destruction. Students explore the scientific, social, economic, and political dimensions of these issues through a multidisciplinary approach and analyse potential solutions.				

Detailed Syllabus

Module	Unit	Content	60 hrs
		Introduction to Environmental Issues	**4**
I	1.1	**Environmental Issues:** Definition. United Nation's Triple Planetary Crisis (Climate change, Pollution and Biodiversity loss). A brief account of the environmental tax.	1
	1.2	**Efforts of UN and UNEP to Reduce Environmental Issues:** The UN Decade on Ecosystem Restoration (2021-2030). A brief account of the UN Environment Programme (UNEP).	1
	1.3	Diversity of life on Earth and humanity's impact on the planet's ecological balance. (The topic can be explored through the screening of the non-copyrighted documentary film "Home" (2009) by Yann Arthus-Bertrand. This film captures landscapes across all continents, including Antarctica, spanning 54 countries. Following the screening, a report can be made based on the documentary).	2

II		**Environmental Issues Associated with Climate Change**	**15**
	2.1	**Climate Change:** Concept of climate change. Causes of climate change (Burning fossil fuels, Deforestation, and Industrial processes). Effects of climate change (Brief account of Rising temperatures, Sea-level rise, Extreme weather events, and Disruptions to ecosystems and biodiversity). (Debate can be adapted for learning).	3
	2.2	**Ozone Layer Depletion:** Definition. A brief account of the Ozone depletion process. Effects of ozone depletion (Effects on human and animal health, Effects on terrestrial plants, Effects on aquatic ecosystems, Effects on bio-geo-chemical cycles, Effects on air quality). Briefly describe control measures.	4
	2.3	**Global Warming:** Concept of global warming. Greenhouse gases - (Carbon dioxide (CO_2), Methane (CH_4), and Nitrous oxide (N_2O), from human activities such as burning fossil fuels for energy, deforestation, industrial processes, and agriculture.	4
	2.4	**Sea Level Rise:** Concept of sea level rise. Causes (Ocean heating, Antarctic ice loss, Greenland ice sheet loss, Mountain glacier loss, and Sea ice loss). Briefly describe its effect on ecosystems and biodiversity. (Discussion mode of learning can be adapted).	4
III		**Pollution-Related Environmental Issues**	**15**
	3.1	**Air Pollution:** Pollution resolution by UN Environment Assembly (2024). Brief accounts on air pollution from fossil fuels, and indoor air pollution health issues.	2
	3.2	**Health issues of Air Pollution:** Death toll associated with air pollution. A brief account of Air pollution-related human diseases (Respiratory infections, Heart disease, Chronic obstructive pulmonary disease (COPD), Stroke, and Lung cancer). (A quiz can be administered utilising the Mentimeter App for the learning experience).	4
	3.3	**Environmental Disasters Caused by Air Pollution:** Brief account of Great Smog 1952 (UK), and Bhopal Gas Tragedy 1994 (India). (Poster presentation can be adapted for learning. Group activity, Maximum 5 students in a group).	3
	3.4	**Water Pollution:** Degradation of aquatic ecosystems – (Fresh, Coastal, and Ocean waters). A brief account of the impact of water pollution on human health.	2
	3.6	**Environmental Disasters Caused by Water Pollution:** *Exxon Valdez* oil spill 1989 and Gulf War oil spill 1991.	1
	3.7	**Soil Pollution:** Mention major causes. Brief account on Microplastics, Oil spills, Mining, Nuclear waste, E-waste, Pesticides, and Herbicides. Mention major cleanup options. Impact of water pollution on human health (Brief account only).	2
	3.9	**Environmental Disasters Caused by Soil Pollution:** Mercury Poisoning at Minamata and Niger Delta oil spills. (Poster presentation can be adapted for learning, Group activity, Maximum 5 students in a group).	1

IV		**Biodiversity Loss**	**10**
	4.1	**Biodiversity Loss:** Concept of Biodiversity loss. Global biodiversity loss. A brief account on Hot spots. Brief account on Convention on Biological Diversity (CBD).	1
	4.2	**Causes of Biodiversity Loss:** Habitat loss, Habitat fragmentation and Habitat degradation, Land use intensification, Nutrient pollution and other forms of pollution (Air and Water pollution). Overexploitation and unsustainable use (Unsustainable fishing methods, Overfishing, Overconsumption and Human overpopulation), Invasive species and their competition with indigenous species, and Climate change**.** (Quiz competition can be adapted for mode of learning, Group activity, Maximum 5 students in a quiz team).	5
	4.3	**Biodiversity Loss and its Impacts on Ecosystems:** Food, Agriculture, Health, and Medicine.	2
	4.4	**Loss of Critical Biodiversity on a Global Scale:** Coral Bleaching and Biodiversity Loss in Great Barrier Reef of Australia, 2019 Amazon rainforest wildfires. (Poster presentation by students can be adapted for the learning experience, Group activity, Maximum 5 students in a group).	2
V		**Significant Environmental Challenges on a Global Scale**	**16**
	5.1	**Water Scarcity:** Concept of water scarcity. Water stress, droughts, and conflicts over water resources. Impact on agriculture, industry, and human health. Economic impacts on society. Brief account on water conservation strategies.	2
	5.2	**Desertification:** Definition. Causes (Immediate causes, Influence of human activities, Natural variations, Climate change). A brief account of effects (Sand and dust storms, Food insecurity, Increasing poverty). Mention major geographic areas affected by desertification (Sahel, Gobi Desert and Mongolia, South America). Mention reversal of desertification through improving soil quality, desert greening, better managed grazing and planting trees. (PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group).	3
	5.3	**Eutrophication:** Nitrogen pollution, Effect of eutrophication on aquatic ecosystems. (Poster presentations by students can be adapted for the learning experience, Group activity, Maximum of five students in a group).	2
	5.4	**Ocean Acidification:** Definition. Cause and effects. Impacts on oceanic calcifying organisms, Harmful algal bloom, Impact on fish larvae. Impacts on fishery and tourism industry. Mention the UN Ocean Decade program Ocean Acidification Research for Sustainability and Global Ocean Acidification Observing Network (GOA-ON). (PowerPoint presentations by students can be adapted for the learning experience. Group activity, Maximum of five students in a group).	2
	5.5	**Microplastic Pollution:** Definition. Sources. Effects on marine life, Food chain contamination, and risks to human health. (Awareness lecture and a Quiz competition for students can be adapted, A Maximum of five	2

		students in a Quiz Team).	
	5.6	**Nuclear Accidents:** Nuclear accidents and their environmental impact. Brief account of the Three Mile Island Accident 1979, Chernobyl Disaster 1986 and Fukushima Accident 2011. (Poster presentation by students can be adapted for the learning experience, Group activity, A Maximum of 5 students in a group).	1
	5.7	**Acid Rain:** Natural and anthropogenic, Adverse effects on surface waters and aquatic animals, Soil acidification, Forests and other vegetation. Mention prevention methods.	2
	5.8	**Sharp Decrease of Forest Cover:** Causes (Deforestation, Illegal logging, Agricultural expansion, Urbanization, Infrastructure development, Forest fires, and Climate change). Mention environmental consequences of forest cover loss (Biodiversity loss, Habitat fragmentation, Soil erosion, Loss of ecosystem services, Disruption of hydrological cycles, Increased greenhouse gas emissions, and Climate change). Social and economic implications on local communities, indigenous peoples, and forest-dependent populations. (PowerPoint presentations by students can be adapted for learning experience, Group activity, Maximum of 5 students in a group).	2

References

1. Gary S. Moore (2015). Global Environmental Issues, Routledge.
2. David E. Lorey (2017). Global Environmental Issues, CRC Press.
3. Frances Harris (2019). Global Environmental Issues, Wiley-Blackwell.
4. Dube R. K. (2008). Global Environmental Issues, Daya Publishing House.
5. Richard N. L. and Andrews (2012). Environmental Science: Global Environmental Issues, Jones & Bartlett Learning.

Suggestive Readings:

1. Elizabeth Kolbert (2014). The Sixth Extinction: An Unnatural History. Henry Holt and Co.
2. Naomi Klein (2014) This Changes Everything: Capitalism vs. The Climate. Simon & Schuster.
3. David Wallace-Wells (2019). The Uninhabitable Earth: Life After Warming. Tim Duggan Books.
4. Rachel Carson (1962). Silent Spring. Houghton Mifflin.
5. Jeff Goodell (2017). The Water Will Come: Rising Seas, Sinking Cities, and the Remaking of the Civilized World. Little, Brown and Company.
6. Bill McKibben (1989). The End of Nature. Random House.
7. Elizabeth Kolbert (2014). The Sixth Extinction: An Unnatural History. Henry Holt and Co.
8. Richard Leakey and Roger Lewin (1995). The Sixth Extinction: Patterns of Life and the Future of Humankind. Anchor Books.
9. Bill McKibben (2010). Eaarth: Making a Life on a Tough New Planet. Henry Holt and Co.
10. Bengt-Owe Jansson, C. S. Holling, Carl Folke, Charles Perrings, Karl-Goran Maler (1997). Biodiversity Loss: Economic and Ecological Issues. Cambridge University Press.

11. Bill Gates (2021). How to Avoid a Climate Disaster: The Solutions We Have and the Breakthroughs We Need. Published by Knopf.
12. Tom Rivett-Carnac (2020). The Future We Choose: Surviving the Climate Crisis. Published by Knopf.

Web resources:

1. https://www.youtube.com/watch?v=jqxENMKaeCU
2. https://www.unep.org/news-and-stories/story/soil-pollution-risk-our-health-and-food-security
3. https://www.fao.org/documents/card/en?details=cb4894en
4. United Nations Environment Programme (UNEP): https://www.unep.org
5. World Wildlife Fund (WWF): https://www.worldwildlife.org
6. Intergovernmental Panel on Climate Change (IPCC): https://www.ipcc.ch
7. National Geographic Environment: https://www.nationalgeographic.com/environment
8. Environmental Protection Agency (EPA): https://www.epa.gov
9. Global Environment Facility (GEF): https://www.thegef.org
10. Climate Action Tracker: https://climateactiontracker.org
11. Greenpeace: https://www.greenpeace.org
12. The Nature Conservancy: https://www.nature.org
13. Earthwatch Institute: https://earthwatch.org
14. Chernobyl Disaster 1986: https://www.britannica.com/video/180283/disaster-Chernobyl-video-repercussions
15. https://www.britannica.com/event/Fukushima-accident

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain a foundational understanding of environmental issues and analyse the efforts of the UN and the UNEP in addressing global environmental challenges.	U, An	1, 7
CO-2	Develop a comprehensive understanding of the science behind climate change, including the causes, mechanisms, and impacts on the Earth's systems.	U, Ap, An	1, 3, 7
CO3	Gain a comprehensive understanding of various forms of pollution and evaluate them at a global scale.	R, U, Ap, E	1, 2, 3, 7
CO4	Analyse the interconnectedness between biodiversity loss and its impacts on ecosystem services and planetary health.	U, Ap, E	1, 3, 7

CO5	Equip with the knowledge and skills necessary to analyse, address, and advocate for solutions to major global environmental issues.	U, An, E	1, 2, 3, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Environmental Science I- Global Environmental issues
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Gain a foundational understanding of environmental issues and analyse the efforts of the UN and the UNEP in addressing global environmental challenges.	PO-1, 6, 8/ PSO-1, 7	U, An	F, C	L	-
2.	Develop a comprehensive understanding of the science behind climate change, including the causes, mechanisms, and impacts on the Earth's systems.	PO-1, 6, 8/ PSO-1, 3, 7	U, Ap, An	F, C	L	-
3.	Gain a comprehensive understanding of various forms of pollution and evaluate them at a global scale.	PO-1, 2, 6, 8/ PSO- 1, 2, 3, 7	R, U, Ap, E	F, C	L	-
4.	Analyse the interconnectedness between biodiversity loss and its impacts on ecosystem services and planetary health.	PO-1, 6, 8/ PSO-1, 3, 7	U, Ap, E	F, C	L	-
5	Equip with the knowledge and skills necessary to analyse, address, and advocate for solutions to major global environmental issues.	PO-1, 2, 6, 8/ PSO- 1, 2, 3, 7	U, An, E	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1	-	-	-	-	-	2	1	-	-	-	-	2	-	3
CO 2	1	-	1	-	-	-	2	1	-	-	-	-	2	-	2
CO 3	1	1	2	-	-	-	2	1	2	-	-	-	2	-	2
CO 4	1	1	2	-	-	-	1	1	-	-	-	-	2	-	3
CO 5	1	-	1	-	-	-	1	1	2	-	-	-	2	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low
2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:

Suggested Assignments (Any 2)

1. Conduct a comparative analysis of renewable energy policies and their effectiveness in different countries.
2. Propose strategies for mitigating the impact of invasive species on native biodiversity.
3. Investigate the role of fossil fuels in contributing to climate change.
4. Assess the socio-economic impacts of water scarcity in developing countries.
5. Analyse the impact of urbanisation on air quality and public health.

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Tests
4. PowerPoint/Poster presentations
5. Quiz/Discussion/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions

3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	-	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	-	-	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK3VACZOO201**				
Course Title	**Nutrition, Health and Wellness**				
Type of Course	**VAC**				
Semester	III				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Pass in class XII				
Course Summary	This course provides a comprehensive understanding of nutrition and wellness, nutritional requirements for healthy life, importance of dietary fibre and water in diet and malnutrition. Students recollects food adulterants and common food preservatives used in food products and thereby emphasis the value of healthy food for a healthy society. Students will gain knowledge about health benefits through regular exercise, stress management and relaxation techniques that enable them to lead a healthy life.				

Detailed Syllabus

Module	Unit	Content	30 hrs
I		**Introduction to Nutrition**	**8**
	1.1	Definition and classification of nutrition-macronutrients (carbohydrate, protein, lipid and fat) and micronutrients (minerals and vitamins); its source and functions. Vitamin deficiency disorders (Brief account).	4
	1.2	Importance of dietary fibre and water in diet.	2
	1.3	Malnutrition – overnutrition (obesity and its types) and undernutrition (Kwashiorkor, Marasmus).	2

II	**Nutritional requirements**		**4**
	2.1	Nutritional requirements during pregnancy, lactation, infant growth, childhood, adolescence and adulthood.	3
	2.2	Balanced diet and its importance in health management.	1
III	**Health and wellness**		**10**
	3.1	Concept of health and wellness, dimension and determinants.	2
	3.2	Health benefits of regular physical activity.	2
	3.3	Type of exercise – aerobic and anaerobic (Brief account).	2
	3.4	Mind and body connection in health – concept and relation, Stress management and relaxation techniques-deep breathing, Progressive Muscle Relaxation (PMR), Yoga and meditation (Brief account only).	4
IV	**Healthy diet for Wellbeing**		**5**
	4.1	Food adulteration- Mention any two examples.	1
	4.2	Common food preservatives – Mention any four examples.	1
	4.3	Diet to prevent obesity, hypertension, cardiovascular diseases, diabetes and cancer.	2
	4.4	Fast-food culture and its health implications.	1
V	**Lifestyle diseases**		**3**
	5.1	Hypokinetic diseases (brief account only).	3

References

1. Ghosh S. (1981). The feeding care of infants and young children, UNICEF, New Delhi.
2. Gibney M.J (2013) Public Health Nutrition, Blackwell publishing, The Nutrition Society Textbook Series.
3. Gopalan C. Ramasastri B.S. & Balasubramanian S. C. (1971) Nutritive value of Indian foods. National Institute of Nutrition, Hyderabad.
4. Guyton,A.C and Hall,J.E.Text Book of Medical Physiology.
5. Manay, M.s. and Shadaksharaswamy, M. (1998). Food – Facts and Principles, New age international (P) Ltd.
6. Mudambi, S. R (1995). Fundamentals of Food and Nutrition. New age international, New Delhi.
7. Swaminathan,M. (1989). Hand book of food and nutrition. Bappco, Bangalore.
8. The complete manual of Fitness and Well-being (1988) The Reader's digest Association, Inc.Pleasatville, New York /Montreal.
9. Wong,K.V (2017) Nutrition, Health and Disease.

Web resources

1. https//www. frost-flow.org
2. https//www. wholisticmatters.com

3. https//www. nin.res.in
4. https//www.res.in.
5. https//www. nia.nih.gov

Practicum (30 hrs)

Sl. No	Contents
1	Measure the BMI of different categories
2	Analysis and interpretation of nutritional information on food labels
3	Methylene Blue Reductase (MBR) test for milk quality checking
4	Testing adulteration of common food items (Any five)
5	Identification and comment on any four nutritional disorders
6	Performing of Yoga and relaxation exercise and it's recording

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO1	Understand about nutrition, wellness and nutritional requirements for healthy life and importance of dietary fibre and water in diet.	U, R	PSO-1,3
CO2	Remember the nutritional disorders and their symptoms.	R, U	PSO-1,3
CO3	Create an insight into the basic knowledge of food preservation and Adulteration.	U, An	PSO-1,2
CO4	Understand the importance of diet to prevent obesity, hypertension, cardiovascular diseases, diabetes and cancer. Analyse fast-food culture and its health implications.	U, An, E	PSO-1,2
CO5	Analyse the importance of exercise and yoga in daily life and its value in daily routine to lead a healthy life.	An, Ap	PSO-5,6,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Nutrition, Health and Wellness
Credits: 2:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand nutrition, wellness and nutritional requirements for healthy life importance of dietary fibre and water in diet.	PO - 1 PSO-1,3	U, R	F,	L	P
2	Remember the nutritional disorders and their symptoms.	PO - 1 PSO-1,3	R, U	F	L	P
3	Create an insight into the basic knowledge of food preservation and adulteration.	PO -1,2,3 PSO-1,2	U, An	F, P	L	P
4	Understand the importance of diet to prevent obesity, hypertension, cardiovascular diseases, diabetes and cancer. Analyse fast-food culture and its health implications.	PO -1,2,3 PSO-1,2	U, An, E	F, C	L	P
5	Analyse the importance of exercise and yoga in daily life and its value in daily routine to lead a healthy life.	PO-2,6,8 PSO-5,6,7	An, Ap	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8
CO 1	1	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO 2	1	-	2	-	-	-	-	1	-	-	-	-	-	-	-
CO 3	1	2	-	-	-	-	-	1	2	3	-	-	-	-	-
CO 4	1	2	-	-	-	-	-	1	2	3	-	-	-	-	-
CO 5	-	1	-	-	1	2	3	-	1	-	-	-	2	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment /Seminar topics

1. Fast-food culture in Kerala
2. Common adulterants
3. Lifestyle diseases
4. Importance of physical activities
5. Listing healthy foods
6. Computer aided diet analysis and nutrition counselling for different age groups
7. Vitamin deficiency diseases

Continuous Comprehensive Assessment

1. Quiz
2. Assignment
3. Monitoring of yoga and exercise
4. Group discussion
5. Internal exam

End Semester assessment

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Practical examination

Mapping of COs to Assessment:

	Internal Exam	Assignment/Quiz	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5		✓		✓

SEMESTER IV

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4DSCZOO201**				
Course Title	**Chordate Diversity - Part II**				
Type of Course	**DSC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	The course provides an in-depth exploration of reptiles, birds, mammals, and primates. It covers general characteristics, classification, and examples of reptiles, as well as the phylogeny of Clade Sauropsida. Students learn about the origin and evolutionary path of birds, including flightless and flying species. The course also examines egg-laying, pouched, and placental mammals, along with a dedicated section on primates and animals from extreme environments. Through lectures, activities, and field visits, students gain a comprehensive understanding of chordates diversity and adaptations, highlighting their significance in ecosystems and human society.				

Detailed Syllabus

Module	Unit	Content	45 Hrs
I		**Reptiles**	**15**
	1.1	**Reptiles:** Key characteristics of reptiles (Amniotic eggs, dry skin, and thoracic breathing), as well as the origin and evolution of reptiles (Brief account only). **Modern Reptiles:** Brief account of the essential characteristics of modern reptiles. Mention Turtles and tortoises, Tuataras, Lizards and snakes, Crocodiles, and alligators. The concept of phylogeny of Clade Sauropsida (Brief account only).	3

	1.2	**Turtles and Tortoises:** General characters. A brief account of evolutionary significance. Mention differences between turtles and tortoises. Scientific classification, IUCN status, distribution, salient features, threats and conservation of Green sea turtle (*Chelonia mydas)* and Indian star tortoise (*Geochelone elegans*).	2
	1.3	**Tuataras:** General characters. A brief account of evolutionary significance. Scientific classification, IUCN status, distribution, salient features, threats and conservation of Tuatara (*Sphenodon punctatus*).	1
	1.4	**Lizards and Snakes:** General characters. A brief account of evolutionary significance. **Lizards:** Scientific classification, IUCN status, ecology, and salient features of Dussumier's forest skink (*Sphenomorphus dussumieri*) and Oriental garden lizard (*Calotes versicolor*). **Snakes:** **Venomous Snakes:** Scientific classification, IUCN status, distribution, salient features, threats, conservation and nature of venom of Indian cobra (*Naja Naja*), Banded krait (*Bungarus fasciatus*), and Malabar pit viper (*Craspedocephalus malabaricus*). **Nonvenomous Snakes**: Scientific classification, IUCN status, distribution, salient features, threats, and conservation of Keeled rat snake (*Ptyas carinata*), the Indian python (*Python molurus*), and the Wolf snake (*Lycodon aulicus*).	7
	1.5	**Crocodiles and Alligators:** General characters. A brief account of evolutionary significance. Scientific classification, IUCN status, distribution, salient features, threats and conservation of Fish-eating crocodile (*Gavialis gangeticus*) and American alligator (*Alligator mississippiensis*).	2
II		**Birds**	**10**
	2.1	**Birds:** Key characteristics (Different types of feathers and flight skeleton), Evolutionary path to birds, Brief account of characteristics of modern birds (Efficient respiration, Efficient circulation, and Endothermy). Mention the position of birds in a cladistic sense.	3
	2.2	**Flightless Birds:** General characters. Scientific classification, IUCN status, distribution, salient features and threats of Common ostrich (*Struthio camelus*) - Mention breathing adaptation and	3

		predators, Common kiwi (*Apteryx australis*) and King penguin (*Aptenodytes patagonicus*).	
	2.3	**Flying birds:** General characters., Scientific classification, IUCN status, distribution, salient features, threats, and conservation of Rock pigeon (*Columba livia*), Indian Cuckoo (*Cuculus micropterus*) - Mention brood parasite behaviour, Great Pied Hornbill (*Buceros bicornis)*, Little cormorant (*Microcarbo niger*), Common Kingfisher (*Alcedo atthis*) and Barn Owl (*Tyto alba*).	4
III	**Mammals**		**10**
	3.1	**Mammals:** Fundamental characteristics (Hair and Mammary glands) and notable features (Endothermy and Placenta). Origin of mammals, Mention Modern mammals (Egg laying mammals, Pouched mammals, and Placental Mammals).	2
	3.2	**Egg-laying mammals (Monotremes):** General characters, retention of reptilian characters. Scientific classification, IUCN status, distribution, salient features, threats, and conservation of Short-beaked echidna (*Tachyglossus aculeatus*) and Duck-billed platypus (*Ornithorhynchus anatinus*).	2
	3.3	**Pouched mammals (Marsupials):** General characters. Mention the origin and pattern of embryonic development. Scientific classification, IUCN status, distribution, salient features, threats, and conservation of Red Kangaroo (*Macropus rufus*) and Koala (*Phascolarctos cinereus*).	3
	3.4	**Placental Mammals:** General characters. Mention the speciality of the placenta. Scientific classification, IUCN status, distribution, salient features of Asian elephant (*Elephas maximus*) and Ganges river dolphin (*Platanista gangetica*).	3
IV		**The World of Living Primates (A mammalian group that includes Lemurs, Lorises, Tarsiers, Monkeys, Apes, and Humans)**	**7**
	4.1	**Living primates:** Brief account on primatology. Distinct features of primates (Grasping fingers and toes, Binocular vision).	1
	4.2	**Lemurs:** General features. A brief account of the Ring-tailed lemur (*Lemur catta*). Lorises: General features. A short account of the Pygmy slow loris (*Xanthonycticebus pygmaeus*). Tarsiers: General features. A brief account of Philippine tarsier (*Carlito syrichta*).	3
	4.3	Monkeys: General features. A brief account of Lion-tailed macaque (*Macaca silenus)*. Ape: General features. A short account of Chimpanzee (*Pan troglodytes*), Gorilla (*Gorilla gorilla*). Hominids	3

		(Humans and their direct ancestors): General features. Brief account of Humans (*Homo sapiens*).	
V		**Reptiles, Birds and Mammals in the Extreme Environments**	**3**
	5.1	**Extreme Environments:** Brief account of the habitats and adaptations of the organisms. **Cold climate (Ice):** Brief account of Emperor penguin (*Aptenodytes forsteri*), Snow Leopard (*Panthera uncia*), and Polar Bear (*Ursus maritimus*). Mention the following examples: Arctic Fox (*Vulpes lagopus*), Reindeer (*Rangifer tarandus*), Arctic hare (*Lepus arcticus*), Walrus (*Odobenus rosmarus*), and Snowy owl (*Bubo scandiacus*). **Hot climate (Desert):** Brief account of Dromedary Camel (*Camelus dromedarius*), Gila monster (*Heloderma suspectum)* and Giant kangaroo rat (*Dipodomys ingens*). Mention the following examples: Mongolian wild ass (*Equus hemionus*), Desert tortoise (*Gopherus agassizii*), Jerboa (*Allactaga jaculus*), Addax (*Addax nasomaculatus*) and Desert horned lizard (*Phrynosoma platyrhinos*).	3

References

1. Lal S.S. (2018). Practical Zoology. Rastogi Publications.
2. Michael J. Benton (2024).Vertebrate Palaeontology, 5th edition, Wiley.
3. Parker & Haswell A. (2005). Text Book of Zoology Vol.II, Macmillan.
4. Peter H. Raven, George B. Johnson, Kenneth A. Mason, Jonathan Losos, and Susan Singer, Carleton College (2017). Biology, 10th edition, McGraw Hill Education.
5. Young, J.Z. (2004). The Life of Vertebrates, 3rd Edition, Oxford University Press.

Suggested Reading:

1. Daniel J.C. (2002). The Book of Indian Reptiles and Amphibians. Bombay Natural History Society.
2. Dileepkumar R. (2016). A Handbook on Snakes of Kerala, Kerala Bhasha Institute.
3. Harvey Pough F. and Christine M. Janis (2019). Vertebrate Life, 10th Edition, Oxford University Press.
4. Kailash Chandra Amitava Majumder, Gopinathan Maheswaran, and Imran Alam (2022). Birds of India. Zoological Survey of India.
5. Scott Weidensaul (2022). A World on the Wing. Picador-The Smithson, London.
6. Vivek Menon (2023). Indian Mammals. Hachette India.

Web Resources:

1. https://www.britannica.com/animal/sifaka
2. https://www.britannica.com/topic/Our-Nonconscious-Future-2119857
3. https://www.britannica.com/list/7-of-the-worlds-most-dangerous-lizards-and-turtles
4. https://epgp.inflibnet.ac.in

Practicum (30 hours)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

(All items to be done from Sl.No.1 to Sl.No.9 and any 4 items to be done from Sl. No.10 to Sl.No.18)

Sl. No.	Contents
1	**Turtles & Tortoises -** Olive ridley sea turtle (*Lepidochelys olivacea*), Indian flapshell turtle (*Lissemys punctata*) and Travancore tortoise (*Indotestudo travancorica*): Spotter, Salient features (Use photos/drawings).
2	**Reptiles -** Common chameleon (*Chamaeleo chamaeleon*), Komodo dragon (*Varanus komodoensis*), Marine iguana (*Amblyrhynchus cristatus*): Spotters, Salient features (Use photos/drawings).
3	**Snakes** - King cobra (*Ophiophagus hannah*), Beaked sea snake (*Hydrophis schistosus),* and Indian green pit viper (*Craspedocephalus gramineus*) and Checkered keelback (*Fowlea piscator*): Spotters, Salient features (Use photos/drawings).
4	**Crocodiles & Alligators -** Mugger crocodile (*Crocodylus palustris*), Chinese alligator (*Alligator sinensis*): Spotters, Salient features (Use photos/drawings).
5	**Flightless Birds -** Common kiwi (*Apteryx australis*) and Emu (*Dromaius novaehollandiae*): Spotters, Salient features (Use photos/drawings).
6	**Flying Birds -** Common swift (*Apus apus*), Eurasian teal (*Anas crecca*), Common tea peregrine falcon (*Falco peregrinus*) and Bar-headed goose (*Anser indicus*): Spotters, Salient features (Use photos/drawings).
7	**Egg-laying mammals (Monotremes):** Western long-beaked echidna (*Zaglossus bruijnii*) and Duck-billed platypus (*Ornithorhynchus anatinus*): Spotters, Salient features (Use photos/drawings).
8	**Pouched mammals (Marsupials):** Tasmanian devil (*Sarcophilus harrisii*) and Musky rat-kangaroo (*Hypsiprymnodon moschatus*): Spotters, Salient features (Use photos/drawings).
9	**Placental Mammals:** African bush elephant (*Loxodonta africana*) and Dugong (*Dugong dugon*): Spotters, Salient features (Use photos/drawings).

10	Construct a flowchart on the relationship of the tuatara to other living reptiles and birds (Group activity).
11	Make a poster on major reptilian orders, including typical examples and key characteristics (Group activity).
12	Make a poster on any five turtles and tortoises in India (Group activity).
13	Make a PowerPoint presentation of any two dinosaurs of your choice and include details on their habitat, distribution, salient features, adaptations, and causes of extinction (Group activity, Maximum time - 10 Minutes).
14	Make a poster on the evolutionary path from reptiles to birds using drawings/photographs (Group activity).
15	Visit the nearest Zoo and prepare an annotated list of 5 reptiles, 5 birds and 5 mammals/Visit a Biodiversity Museum and prepare a report on reptilian, bird and mammalian diversity.
16	Identify any five birds from your college campus and make a report (Individual reports).
17	Celebration of International Primate Day - September 1/National Bird Day (January 5)/World Migratory Bird Day (Second week of May)/World Sparrow Day/World Animal Day - October 4 (March 20)-(Quiz/Invited talk/Photography exhibition/Documentary show).
18	Talk on the topic 'Common Snakes of your Locality' by experts from the Department of Forest Govt of Kerala or other competent experts in the field.

References:

Recommended Reading

1. Peter H. Raven, George B. Johnson, Kenneth A. Mason, Jonathan Losos, and Susan Singer, Carleton College (2017). Biology, 10th edition, McGraw Hill Education.
2. Young, J.Z. (2004). The Life of Vertebrates, 3rd Edition, Oxford University Press.
3. Lal S.S. (2018). Practical Zoology. Rastogi Publications.

Suggested Reading

1. Harvey Pough F. and Christine M. Janis (2019). Vertebrate Life, 10th Edition, Oxford University Press.

2. Kailash Chandra Amitava Majumder, Gopinathan Maheswaran, and Imran Alam (2022). Birds of India. Zoological Survey of India.
3. Dileepkumar R. (2016). A Handbook on Snakes of Kerala, Kerala Bhasha Institute.

Web Resources:

1. https://www.britannica.com
2. https://animaldiversity.org
3. https://cmfri.com/library-museum.html
4. https://www.museumsofindia.org/museum/12251/kerala-biodiversity-museum
5. https://tnhm.in
6. https://naturalhistory.si.edu

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain an understanding of the fundamental characteristics of chordates and explore the concept of cladograms.	U	1, 2, 3
CO-2	Gain insight into the scientific classification, unique characteristics and evolutionary significance of selected reptiles, birds, and mammals.	R, U	1, 2 3, 4
CO-3	Examine the diversity and unique adaptations of chordates thriving in extreme climatic conditions.	U, Ap	1, 2, 4
CO4	Foster a commitment to chordate conservation by engaging in experiential learning activities, collaborative teamwork, and honing presentation abilities to effectively communicate the importance of preserving these organisms and their habitats	U, Ap, An	1, 2, 3, 4, 7
CO5	Develop proficiency in identifying indigenous bird species and generating scientific reports based on observations and findings.	U, Ap, An, E	1,2,3,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Chordate Diversity-Part II

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Gain an understanding of the fundamental characteristics of chordates and explore the concept of cladograms.	PO-1/PSO-1, 2, 3	U	F, C	L	-
CO-2	Gain insight into the scientific classification, unique characteristics and evolutionary significance of selected reptiles, birds, and mammals.	PO-1, 2, 3/ PSO-1, 2, 3, 4	R, U	C, P	L	P
CO-3	Examine the diversity and unique adaptations of chordates thriving in extreme climatic conditions.	PO- 1, 2, 5/ PSO-1, 2, 4	U, Ap	C, P	L	P
CO-4	Foster a commitment to chordate conservation by engaging in experiential learning activities, collaborative teamwork, and honing presentation abilities to effectively communicate the importance of preserving these organisms and their habitats	PO-1, 2, 3, 5/ PSO-1, 2, 3, 4,7	U, Ap, An	C, P	L	P
CO-5	Develop proficiency in identifying indigenous bird species and generating scientific reports based on observations and findings.	PO-3, 5, 6/ PSO-1, 2, 3, 7	U, Ap, An, E	C, P, M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

CO	PSO 1	PSO2	PSO3	PSO4	PSO 5	PSO 6	PSO 7	PO 1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8
1	2	2	1	-	-	-	-	1	-	-	-	-	-	-	-
2	1	2	2	3	-	-	-	1	2	1	-	-	-	-	-
3	1	3	-	2	-	-	-	1	1	-	-	1	-	-	-
4	2	3	3	2	-	-	1	2	1	2	-	1	-	-	-
5	1	1	3	-	-	-	1	-	-	1	-	2	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low
2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:

Assignments (Any two)

1. Investigate the conservation status of a specific reptile species and propose management strategies for its protection.
2. Prepare an identification key for differentiating venomous and nonvenomous snakes.
3. Analyse the conservation status of a threatened or endangered bird species and propose conservation measures to protect it.
4. Analyse the adaptations of mammals to various environments, such as deserts, forests, or aquatic ecosystems.

Continuous Comprehensive Assessment

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examinations

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examinations

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO-1	✓	✓	-	✓
CO-2	✓	✓	-	✓
CO- 3	✓	✓	-	✓
CO- 4	✓	✓	-	✓
CO- 5	✓	✓	-	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4DSCZOO202**				
Course Title	**Evolution and Zoogeography**				
Type of Course	**DSC**				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass of Class XII				
Course Summary	This course provides a comprehensive understanding of evolutionary biology, including classical and modern concepts, human evolution, and zoogeography, enabling students to grasp the complex mechanisms and patterns of life's diversity on Earth. Overall, students will gain a deep understanding of evolutionary processes, and the distribution of life forms on Earth, preparing them for advanced studies and careers in evolutionary biology, ecology, and related fields.				

Detailed Syllabus

Module	Unit	Content	45 hrs
Evolution			
I	**Introduction to Evolution**		**5**
	1.1	Theories of organic evolution: Lamarck's theory; Weisman's germplasm theory; Darwin's theory of natural selection and the contributions of Wallace. Evolution- types- Micro, Macro, Mega and Co-evolution.	2
	1.2	Natural selection- Variability, Fitness and different environmental conditions. Types of selection (brief account of the observation in *Biston betularia*).	1
	1.3	Speciation- Types; Isolation and isolating mechanisms.	1

	1.4	Hybridization- adaptive radiation with special reference to Darwin's finches.	1
II	**Modern Concepts of Evolution**		**8**
	2.1	Geological Time scale -Brief description on Paleontological evidences and Fossil dating.	2
	2.2	Modern concept of organic evolution: (Neo Darwinism), Sources of Variation: mutation, role of mutation in evolution, neutral mutation (Kimura).	2
	2.3	Genetic basis of evolution- gene pool, gene frequency, genetic drift, genetic equilibrium; factors affecting genetic equilibrium and Hardy – Weinberg law.	4
III	**Human Evolution**		**17**
	3.1	Evolution of Man- Brief account – Hominid fossils.	3
	3.2	Molecular Basis of Evolution; Contributions of Svante Paabo (Paleogenomics, Paleoanthropology).	3
	3.3	Phylogenetic Tree -Distance and Parsimony methods.	2
	3.4	Evolution of Gene families- Molecular Drive.	2
	3.5	Origin of new genes and proteins, Migration and Random Genetic Drift, Convergent Evolution-Sexual selection and gene pool mixing.	4
	3.6	Extinction - Background and mass Extinctions (causes and effects) and K-T Extinction.	3
Zoogeography			**15**
IV	**Introduction to Zoogeography**		**5**
	4.1	Branches of Zoogeography- Applied, Casual and descriptive.	1
	4.2	Patterns of animal distribution- cosmopolitan, dis-continuous, bipolar and isolated distribution, factors affecting animal distribution.	2
	4.3	Barriers and means of dispersal (Land and Aquatic ecosystems).	2
V	**Zoogeographical realms**		**10**
	5.1	Brief account of each realm, mention the areas, physical features and peculiarities of fauna. Palaearctic realm, Australian realm, Ethiopian realm, Nearctic realm, Oriental realm and Neotropical realm.	4
	5.2	Bio-geographical classification of India- Biodiversity hotspots in India - Western Ghats, Eastern Ghats and Himalayas. Insular Fauna: Brief	4

		account of oceanic islands (Galapagos) and continental islands (British Isles).	
	5.3	Plate tectonics and Continental Drift theory (Brief account).	2

References

1. A brief introduction to Zoogeography, Muhammad Bilal.
2. A text book of Zoogeography (2018), Frank E Beddard, Forgotten Books publishers, ISBN-10: 1331879310
3. An introduction to evolution and Zoogeography (2009), T K Saha, Emkay Publications, ISBN-10: 8185712115
4. Brace, C. L. (1967). The stages of Human Evolution, Prentice Hall International. Cambridge University Press.33.
5. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
6. Colbert E.H. (1980). Evolution of the Vertebrates, John Wiley & Sons. Corporation, NewYork
7. Dadson E.O. (1960). Evolution: Process and Product. Reinhold Pub.
8. Darlington P.J.Jr. (1980). Zoogeography: The geographical Distribution of Dehradun, Delhi.
9. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
10. Ehlrich P.R. & holm R.W. (1973). The Proces of Evolution, Mc. Graw- Hill Inc.
11. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
12. Lull R.S. (1947). Organic Evolution Macmillan Pub. Co. New York.
13. Monroe. W. Strickberger 2000. Sudbury (Massachusetts): Jones and Bartlett Publishers. 722p.
14. Moody P.A. (1978) Introduction to Evolution, Ind. Ed. Kalyani Pub., New Delhi
15. Oparin A.I. (1957). The Origin of Life on Earth, Oliver & Boyd, London.Private limited, New Delhi Publishers Ltd.
16. Ridley, M (2004) Evolution III Edition Blackwell publishing.
17. Savage J.M. (1969). Evolution, Hold, Rinchart and Winston Inc. New Delhi.
18. Stebbins G.L. (1977). Process of Organic Evolution, Prentic Hall Inc. Tomorrow printers, New Delhi.
19. Volpe E.P. (1985). Understanding Evolution. *Ind. Repr*. Universal Book Stall.

Web resources:

1. https://www.sciencedaily.com/newsletters.htm
2. https://evolutionnews.org/
3. https://www.biodiversitylibrary.org/
4. https://www.blackwellpublishing.com/ridley/resources.asp

Practicum (30 hrs)

Sl. No	Contents
1	Macro evolution using Darwin Finches (Pictures)

2	Photo of Darwin, Lamark, Wallace and Svante Paabo - Identify the scientist and mention the contribution.
3	Identification of Living fossils (Specimens/Pictures)- Any three
4	Identification of geographical realms (Map).
5	Identification of respective fauna of Zoological regions (pictures).
6	Field visit to any important hotspot area (any regions in Western Ghats). **OR** Visit to Natural History Museum/Biodiversity Museum Submit a report
7	Phylogenetic tree preparation using suitable software's (Demonstration only) Eg: MEGA **OR** Demonstration of OMIM public database using LMS

References

1. Patole S S, Hasim M S and Yuvraj M B (2019) Evolutionary biology: Theory and Practicals, Academic Book publications. Jalgaon.
2. Sai Jyoti U (2022) Ecology, Zoogeography and Evolution-Lab Practical with solutions, SIA Publishers & Distributors Pvt Ltd.
3. Tripurari M (2023) Evolutionary biology with practical, Mahaveer Publications.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the evolutionary mechanisms which can explain the genetic composition and distribution of organisms.	U	PSO-1,2
CO-2	Remember the Zoogeography and its applications for conservations of Biodiversity	R, U	PSO-1,2
CO3	Create an insight into the basic knowledge of the origin of life and molecular concepts of evolution	An	PSO-1,2
CO4	Analyse patterns of animal distribution based on geographic factors, barriers, and means of dispersal in	A	PSO-1,2

	land and aquatic ecosystems.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Evolution and Zoogeography
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Understand the evolutionary mechanisms which can explain the genetic composition and distribution of organisms.	PO 1, PO2/ PSO-1,2	U	F, C	L	P
2.	Remember the Zoogeography and its applications for conservations of Biodiversity.	PO 1/ PSO-1,2	U, R	P	L	P
3.	Create an insight into the basic knowledge of the origin of life and molecular concepts of evolution.	PO 3/ PSO-1,2	A	F, C	L	P
4.	Analyse patterns of animal distribution based on geographic factors, barriers, and means of dispersal in land and aquatic ecosystems.	PO 3/ PSO-1,2	A	F	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	PSO 2	PSO 3	PSO4	PSO5	PSO 6	PO1	PO2	PO3	PO4	PO5	PO6
CO 1	1	2	-	-	-	-	2	2	-	-	-	-

CO 2	2	3	-	-	-	-	3	-	-	-	-	-
CO 3	1	2	-	-	-	-	-	-	2	-	-	-
CO 4	2	1	-	-	-	-	-	-	3	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Assignment/ Seminar topics

1. Prof. Madhav Gadgil
2. Endemic species
3. Origin of life
4. Mass extinction phenomenon
5. Living fossils
6. Adaptive radiation
7. Animal connecting links
8. Plate tectonics and Continental drift theory
9. Biodiversity hotspots
10. Natural Selection
11. Geological Time Scale
12. Patterns of Animal distribution

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of Field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions

2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4DSCZOO203**				
Course Title	**Comparative Anatomy of Vertebrates**				
Type of Course	**DSC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in Class XII				
Course Summary	This course explores the Comparative Anatomy of Vertebrates, focusing on the study of anatomical structures across vertebrate species to understand evolutionary relationships and functional diversity. Beginning with the significance of Comparative Anatomy in biological sciences, it delves into basic principles of vertebrate morphology and its relevance to evolutionary and phylogenetic studies. The course covers the evolution, diversity and comparative anatomy of the skeletal, circulatory, respiratory, digestive and nervous systems across vertebrates. Overall, this course offers a comprehensive understanding of vertebrate anatomy, integrating evolutionary perspectives with functional morphology to explore the unity, diversity, and adaptability of vertebrate life forms.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Comparative Anatomy of Vertebrates**	**8**
	1.1	Comparative Anatomy among Vertebrates – What is it and Why should we study it?	1
	1.2	Importance and Applications of Comparative Anatomy in Biological Sciences (Brief note)	1

	1.3	Evolutionary Perspective in Comparative Anatomy [Brief note]	2
	1.4	Comparative Anatomy and Phylogenetic Relationships [Brief note]	2
	1.5	Basic Principles of Vertebrate Morphology	2
		Related activity: *Group Discussion on – Can Evolutionary perspective be drawn out from studying comparative anatomy?*	
II		**Skeletal System**	**13**
	2.1	Evolution and Diversity of Vertebrate Skeletons	2
	2.2	Axial Skeleton: Skull, Vertebral Column, and Ribs	3
	2.3	Appendicular Skeleton: Limbs and Girdles	2
	2.4	Comparative Analysis of Bone Structure and Function	4
	2.5	Adaptations of the Skeletal System in Different Vertebrate Groups	2
		Related activities: 1. *Collection/ Identification of major Vertebrate bones explained in theory class* *2. Working with online virtual dissection tools.*	
III		**Muscular System**	**14**
	3.1	Evolution and Diversity of Vertebrate Muscles	2
	3.2	Comparative Anatomy of Skeletal, Smooth, and Cardiac Muscles	5
	3.3	Functional Morphology of Muscles in Movement and Locomotion	3
	3.4	Adaptations of Muscular Systems in Different Vertebrate Groups	2
	3.5	Muscle Mechanics and Biomechanics in Vertebrate Locomotion	2
		Related activities: *1. Group discussion on topic – Why are there no Flying Elephants?* *2. Debate on topic – Humans with tail! Good or Bad?*	
IV		**Circulatory and Respiratory Systems**	**13**
	4.1	Evolution and Diversity of Vertebrate Circulatory Systems	2
	4.2	Comparative Anatomy of Heart and Blood Vessels	3
	4.3	Circulatory Adaptations in Different Vertebrate Groups	2
	4.4	Evolution and Diversity of Vertebrate Respiratory Systems	2

	4.5	Comparative Anatomy of Lungs, Gills, and Skin Respiration	4
		Related activities: *1. Quiz on Comparative Anatomy of Vertebrate Circulatory and Respiratory Systems* *2. Group Discussion – Crocodile with four chambered heart – Can this be considered as evolutionary transition between Reptiles and Birds?* *3. Debate – Archaeopteryx – A myth or fact?*	
V	**Digestive and Nervous Systems**		**12**
	5.1	Evolution and Diversity of Vertebrate Digestive Systems	2
	5.2	Comparative Anatomy of Mouth, Stomach, Intestines, and Accessory Organs	3
	5.3	Adaptations of Digestive Systems in Different Vertebrate Groups	2
	5.4	Evolution and Diversity of Vertebrate Nervous Systems	2
	5.5	Comparative Anatomy of Brain, Spinal Cord, and Peripheral Nerves	3
		Related activity: *Group Discussion – Is the nervous system the most important system which makes humans the most advanced among vertebrates?*	

References

1. Kardong, K.V. (2019). Vertebrates: Comparative Anatomy, Function, Evolution (8th Ed.). McGraw-Hill Education.
2. Romer, A.S., and T.S. Parsons. (1985). The Vertebrate Body. Saunders College Publishing.
3. Pough, F. H., Bemis, W., McGuire, B. and Janis, C. (2022). Vertebrate Life (11th Ed.). Oxford University Press. DOI: 10.1093/hesc/9780197558621.001.0001
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6. Brian K. Hall (2015). Bones and Cartilage: Developmental and Evolutionary Skeletal Biology (2nd Ed.). Elsevier Academic Press. https://doi.org/10.1016/C2013-0-00143-0
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8. Kardong, K.V. and Edward Zalisko (2011). Comparative Vertebrate Anatomy: A Laboratory Dissection Guide. McGraw-Hill Education.

Online Resources

1. The Science Bank – Online Dissection Resources

https://thesciencebank.org/pages/online-dissection-resources

2. Human Anatomy in Detail - https://www.innerbody.com/htm/body.html
3. Learn human anatomy in 3D - https://anatomy3datlas.com/
4. Virtual frog dissection tool - https://norecopa.no/norina/virtual-frog-v-frog-20/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Recall the basic principles and importance of comparative anatomy among vertebrates.	**R**	PSO-1
CO-2	Identify the evolutionary perspectives and phylogenetic relationships in comparative anatomy. Explain the evolution and diversity of vertebrate skeletal, muscular, circulatory, respiratory, digestive, and nervous systems.	**R, U**	PSO-3
CO-3	Describe the comparative anatomy of the skeletal, muscular, circulatory, respiratory, digestive, and nervous systems across different vertebrate groups.	**U**	PSO-1, PSO-3
CO-4	Apply knowledge of vertebrate morphology to analyze and compare the bone structure, muscular system, circulatory and respiratory systems, digestive and nervous systems, and their adaptations in different vertebrate groups.	**Ap**	PSO-3, PSO-4
CO-5	Analyze the functional morphology of vertebrate muscles in movement and locomotion, and evaluate the biomechanics involved in vertebrate locomotion.	**An**	PSO-4

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Comparative Anatomy of Vertebrates

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Recall the basic principles and importance of comparative anatomy among vertebrates.	PO1/ PSO-1	R	F, C	L	-

2.	Identify the evolutionary perspectives and phylogenetic relationships in comparative anatomy. Explain the evolution and diversity of vertebrate skeletal, muscular, circulatory, respiratory, digestive, and nervous systems.	PO1,PO3, PO4,PO6, PO7,PO8/ PSO-3	R, U	F, C, P	L	-
3.	Describe the comparative anatomy of the skeletal, muscular, circulatory, respiratory, digestive, and nervous systems across different vertebrate groups.	PO1,PO3, PO4,PO6, PO7,PO8/ PSO-1, PSO-3	U	P	L	-
4.	Apply knowledge of vertebrate morphology to analyze and compare the bone structure, muscular system, circulatory and respiratory systems, digestive and nervous systems, and their adaptations in different vertebrate groups.	PO1,PO3, PO4,PO6, PO7,PO8/ PSO-3, PSO-4	Ap	C, P	L	-
5.	Analyze the functional morphology of vertebrate muscles in movement and locomotion, and evaluate the	PO7, PO8/ PSO-4	An	P	L	-

	biomechanics involved in vertebrate locomotion.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	PSO 2	PSO 3	PSO4	PS O5	PSO 6	PSO 7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 2	-	-	3	-	-	-	-	3	-	1	1	-	2	1	2
CO 3	3	-	1	-	-	-	-	2	-	3	2	-	1	1	1
CO 4	-	-	2	3	-	-	-	1	-	2	2	-	3	2	1
CO 5	-	-	-	3	-	-	-	-	-	-	-	-	-	1	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Topics for Assignment/Seminar

1. Evolutionary Trends in Vertebrate Skeletal Systems.
2. Muscular Systems: Similarities and Differences.
3. Comparative Analysis of Vertebrate Circulatory Systems.
4. Respiratory Adaptations in Aquatic and Terrestrial Vertebrates.
5. Digestive System Evolution: Herbivores vs. Carnivores.

6. Nervous System Complexity Across Vertebrate Groups.
7. Adaptations in Vertebrate Locomotion.
8. Comparative Anatomy of Sensory Systems.
9. Reproductive Strategies in Vertebrates: Oviparity, Viviparity, and Ovoviviparity.
10. Endocrine System Evolution and Hormonal Regulation.
11. Integumentary System: Skin, Scales, and Feathers.
12. Ecological Significance of Vertebrate Anatomy.

Continuous Comprehensive Assessment (CCA)

1. Assignments
2. Seminar
3. Collection/ Identification of major Vertebrate bones explained in theory class
4. Working with online virtual dissection tools
5. Group discussion on topic – Why there are no Flying Elephants?
6. Debate on topic – Humans with tail! Good or Bad?
7. Test
8. Quiz

End Semester Evaluation (ESE)

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics

	Assignment/ Seminar	CCA	ESE
CO 1	-	✓	✓
CO 2	✓	✓	✓
CO 3	✓	✓	✓
CO 4	✓	✓	✓
CO 5	✓	✓	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4DSEZOO201**				
Course Title	**Fisheries Science II - Principles of Aquaculture**				
Type of Course	**DSE**				
Semester	IV				
Academic Level	200 -299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in Class XII				
Course Summary	This course will provide the basics of aquaculture to the students. A wide range of aspects of aquaculture like aquaculture practices, design and construction of farms and hatcheries, pond management, selection of candidate species for aquaculture, study of monoculture, polyculture and integrated culture systems etc. are dealt in this course.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Introduction to Aquaculture**	**10**
	1.1	Present status and Scope of aquaculture in India and Kerala, Consumption scenario and Emerging trend in Aquaculture.	3
	1.2	Criteria for the selection of sites (nutrient and soil quality, water supply and water circulation, water quality, Environmental Impact Assessment)	3

		for various aquaculture practices, (Freshwater, Brackish water and Marine Water)	
	1.3	Criteria for selection of species for culture – biological, economic and market considerations.	1
	1.4	Commercially important common cultivable species and Introduction of exotic species (Brief account only)	3
II	**Systems of aquaculture**		**8**
	2.1	Type of farming Methods: - pond culture, tanks, raceways, pen culture, cage culture and zero water exchange system.	3
	2.2	Different Systems of Aquaculture: Traditional, Extensive, semi-intensive, intensive and super intensive aquaculture in freshwater, brackish water and marine environments. Monoculture, polyculture, Sewage fed Farming, Integrated culture systems, Recirculated aquaculture Systems (RAS) **Related activity**: *Make a report on any systems of aquaculture by visiting the culture areas and submit the report .*	5
III	**Design and construction of farm and hatchery**		**8**
	3.1	Size, shape, lay out of pond farms, dike design and construction, water supply and drainage system.	3
	3.2	Pond productivity, estimation, physical, chemical and biological factors affecting productivity of ponds	2
	3.3	Types, design and construction of hatcheries	3
IV	**Pond Preparation and Stocking**		**10**
	4.1	Pre-stocking Pond management – sun drying, repairing, desiltation, ploughing, liming, eradication of predators and weeds, water filling, fertilization. Importance of bloom	4
	4.2	Seed resources – wild collection, induced breeding of fishes, shrimps and bivalves in hatcheries	4
	4.3	Transportation, acclimatisation of seeds and release, species combinations, stocking density **Related activity**: *Calculate stocking density of shrimp pond based on type of culture.*	2
	Post stocking management		**9**
	5.1	Feed management – Types of feed, formulated feed, feeding rate, feed conversion ratio, feed additives, binders, nutraceuticals, microencapsulated feeds, brooder diet and Live Feed.	3

V	5.2	Monitoring physical and chemical parameters of water, Rate and time of water exchange.	2
	5.3	Monitoring Health of stock, Regular sampling and disease Management. **Related activity:** *Assessment of stock and feeding regime in a shrimp pond based on sampling*	2
	5.4	Harvesting of drainable and undrainable ponds, cages, molluscan farms. Handling and preservation.	2

References

1. Ahilan, B., Ravaneshwaran, K., Kumaravel, P., 2011. Integrated Aquaculture. Daya Publishing House
2. Allan, G. and Burnell, G. 2013. Advances in Aquaculture Hatchery Technology. Woodhead Publishing Limited.
3. Bardach JE. 1997. Sustainable Aquaculture. John Willey and Sons.
4. Bardach JE, Rhyther JH and Mc. Larney WO. 1972. Aquaculture Farming and Husbandry of Freshwater and Marine Organisms. John Wiley and Sons.
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25. Sharma LL, Sharma SK, Saini VP and Sharma BK. (Eds.). 2008. Management of Freshwater Ecosystems. Agrotech Publ. Academy.

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Online resources

- https://www.fao.org/fishery-divisional-structure/en
- https://worldfishcenter.org/publications
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- https://www.cmfri.org.in/about-library
- https://ciba.icar.gov.in/?page_id=11147
- e-Krishi Shiksha (iasri.res.in)
- https://www.cseindia.org/understanding-eia-383

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the definition and history of aquaculture, Status of aquaculture in India and Kerala and criteria for selection of species for culture	U, R, An	4,5
CO-2	Understand systems of aquaculture and different types of aquaculture practices.	U, R, An	4,5
CO-3	Acquire knowledge in design and construction of culture systems and hatcheries	R, U, An	4,5
CO-4	To get familiarised with pre-stocking pond management, seed available and seed stocking.	AP, An, E	4,5
CO-5	To get an awareness on post stocking management practices for a profitable culture.	U, Ap,An	4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Fisheries Science II - Principles of Aquaculture

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the definition and history of aquaculture, Status of aquaculture in India and Kerala and criteria for selection of species for culture	PO2,3,7/ PSO4,5	U, R, An	C, P, M	L	
2	Understand systems of aquaculture and different types of aquaculture practices.	PO2,3,7/ PSO4,5	U,R, An	C, P, M	L	
3	Acquire knowledge in design and construction of culture systems and hatcheries	PO2,3,7/ PSO4,5	R, U, An	C, P, M	L	
4	To get familiarised with pre-stocking pond management, seed available and seed stocking.	PO2,3,7/ PSO4,5	AP, An, E	C, P, M	L	
5	To get an awareness on post stocking management practices for a profitable culture.	PO1,2,3, 7/PSO4,5	U, An	F, C, P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO2	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO3	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO4	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO5	-	-	-	3	3			3	2	3	-	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment / Seminar topics

1. Aquaculture vs Agriculture
2. Environmental Impact Assessment (EIA)
3. Water quality management
4. Multiple uses of water in aquaculture
5. Use of agro-industrial waste and biofertilizer in aquaculture

Continuous comprehensive Assessment

1. Assignment/ Quiz/ Discussion / Seminar
2. Submission of specimen collection report
3. Submission of Field report

End semester Evaluation

1. Very short answer questions
2. Short answer questions
3. Essay type questions
4. Practical examinations

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4	✓			✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4DSEZOO202**				
Course Title	**Entomology II-Industrial Entomology**				
Type of Course	**DSE**				
Semester	IV				
Academic Level	200-299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-		4
Pre-requisites	Pass in Class XII				
Course Summary	After completion of the course the students will be acquainted with apiculture, sericulture and lac culture. This course also provides the students with entrepreneurial opportunities in entomology and provides information on productive insects and their products. Apart from these the students will learn about the methods of pest management in residential places and public buildings and insect pests of public health and their management.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Apiculture**	**15**
	1.1	Introduction to apiculture and Bee biology, Honey bee species occurring in India, Morphological features for identification of different bee species(Related activity- Poster presentation depicting different bee species of India)	8
	1.2	Bee keeping - General colony management during different seasons, Managing colonies for honey production and pollination.	4
	1.3	Bee keeping equipment, honey extraction and bee products. Diseases of bee colonies– preventive and curative measures(Related Activity- Visit to a	3

		bee keeping facility and submission of report on honey extraction process and bee products).	
II	**Sericulture**		**14**
	2.1	History, development and organization of silk industry, Study of different species of silkworms - (1) Mulberry silk worm- *Bombyx mori* and *Bombyx mandarina.* (2) Tasar silk worm - *Antheraea paphia* and *Antheraea pernyi* (3) Muga Silkworm- *Antheraea assama* (4) Eri silk worm- *Philosamia ricini* (Brief description)	5
	2.2	Moriculture (Brief description) Silk and its uses, Rearing of mulberry silkworm (Brief description).	4
	2.3	Pests and diseases of silkworms and management of silkworms(Related Activity- Quiz).	5
III	**Lac culture**		**15**
	3.1	History of lac culture, Morphology and biology of lac insect.	3
	3.2	Different strains of Lac insect- Kusumi and Rangeeni. Lac cultivation- Propagation, inoculation and harvesting.	6
	3.3	Lac processing- Stick lac, Seed lac and Shellac.	3
	3.4	Lac products and their uses- Lac dye, Lac wax and Aleuritic acid (Related Activity- Powerpoint presentation.	3
IV	**Methods of pest management in residential places and public buildings**		**8**
	4.1	Insecticides for domestic use and their safety, Pre and post construction termite proofing of buildings, Appliances for domestic pest control	5
	4.2	Rodent control methods, Organic methods of domestic pest management **Related Activity**- *Field study and Report submission.*	3
V	**Insect pests in human habitation**		**8**
	5.1	Public health importance of insect pests in human habitation.	3
	5.2	Biology, damage and control of mosquitoes, houseflies, bed bugs, ants, termites and cockroaches(Related activity- Powerpoint presentation).	5

References

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4. Partiban S & David BV. 2007. Management of Household Pests and Public Health Pests. Namratha Publ., Chennai.
5. Singh S. 1975. Beekeeping in India. ICAR, New Delhi.

Web resources

1. https://indiaagronet.com › Moriculture
2. https://www.niti.gov.in/honeyed
3. https://www.embibe.com/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the basics about beekeeping tools, equipment, and honey extraction.	U	PSO-1,2
CO-2	Acquire knowledge and understand practices in moriculture, silkworm rearing, lac culture, lac products and their uses.	R, U	PSO-1,2
CO3	Analyze the economic importance of Apiculture, Sericulture and Lac culture.	An	PSO-1,2
CO4	Apply the knowledge on disease management in residential places and public buildings through the control of insect pests in human habitation.	Ap	PSO-1,2
CO5	Apply the knowledge on biology and damage caused by insect pests for their effective control…	Ap	PSO-2,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Entomology II – Industrial Entomology
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Understand the basics about beekeeping tools, equipment, and honey extraction.	PO 1, PO2/ PSO-1,2	U	F, C	L	
2.	Acquire knowledge and understands practices in moriculture, silkworm	PO 1, PO 2/ PSO-1,2	U, R	F, C	L	

	rearing, lac culture, lac products and their uses.					
3.	Analyze the economic importance of Apiculture, Sericulture and Lac culture.	PO 3/ PSO-1,2	An	P	L	
4.	Apply the knowledge on disease management in residential places and public buildings and in the control of insect pest in human habitation.	PO 3/ PSO-1,2	Ap	C. P	L	
5.	Apply the knowledge on biology and damage caused by insect pests for their effective control	PO 1,2,6/PSO – 2,5	Ap	C,P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of Cos with PSOs and Pos:

	PSO1	**PSO2**	**PSO3**	**PSO 4**	**PSO 5**	**PSO6**	**PSO 7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	1	2	-	-	-	-	-	2	2	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	3	1	-	-	-	-	-	-
CO 3	1	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO 4	2	1	-	-	-	-	-	-	-	3	-	-	-	-	-
CO 5	-	2	-	-	3	-	-	1	3	-	-	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics/Field study report

1. Beekeeping as industry in India
2. Preparation of bee-keeping projects.
3. Bio-ecology of mulberry silkworm.
4. Natural enemies of lac insect and their management
5. Insect pests of pet animals and their management.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of Field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of Cos to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4DSEZOO203**				
Course Title	**Environmental Science II- Environmental Pollution**				
Type of Course	**DSE**				
Semester	IV				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in Class XII				
Course Summary	This course covers the comprehensive study of air, water, soil, noise, and light pollution, including their sources, impacts, and mitigation strategies. Students will explore the concepts, standards, and pollutants associated with each type of pollution, along with their effects on human health, wildlife, and ecosystems. Through case studies, students will analyse real-world scenarios, identifying successful management approaches and ongoing challenges. By examining the pathways of contamination and ecological consequences, students will gain insights into the long-term impacts of pollution on both natural and human environments. Additionally, the course highlights the importance of regulatory frameworks and guidelines in addressing pollution issues and promoting sustainable practices for environmental protection.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Air Pollution: Causes and Impacts**	**12**
	1.1	Air Pollution: Concepts, Sources of air pollution- Natural and anthropogenic. Air quality standards, emission standards. Primary and secondary air pollutants. Atmospheric reactions are mechanisms of transformations and their relationship.	3
	1.2	Particulate matter: Sources, classification and composition, particulate dynamics, viable and nonviable particles.	2
	1.3	Effects of air pollution on human health, animals and vegetation.	2

	1.4	Pollution-related phenomena and their consequences: the greenhouse effect, global warming, temperature inversion, CFCs and ozone depletion, and photochemical smog. **Related activity***: A quiz can be administered utilising the Mentimeter App for the learning experience.*	3
	1.5	Case studies on air pollution, threats and challenges. Examples: The Beijing Smog Crisis (2013) and The Delhi Air Pollution Crisis (ongoing). **Related activity***: Poster presentation can be adapted for learning. Group activity, Maximum 5 students in a group.*	2
II	**Water Pollution: Causes and Impacts**		**12**
	2.1	Characteristics of natural water and aquatic environment. Sources of potable water. Water quality standards- WHO, EPA and BIS. Industrial water quality standards.	3
	2.2	Types of water pollution: Physical, chemical, biological, and physiological. Sources of water pollution, such as domestic and industrial wastewater, their compositions, discharge standards, and effects on receiving bodies.	2
	2.3	The fate of pollutants in water: Metals, heavy metals, non-metals, and their specifications. Pesticides, oils, greases, organic matter, biodegradation, and bioaccumulation and their effects on water bodies.	2
	2.4	Marine, thermal, and radioactive pollution in water and their consequences; transport of pollutants; pollutant cycle in the environment (land, air, and water). Bioaccumulation and Biomagnification. **Related activity**: *Quiz competition can be adapted for mode of learning, Group activity, Maximum 5 students in a quiz team.*	3
	2.5	Case studies on water pollution, threats and challenges. Examples: The Cuyahoga River Fire (1969), The Love Canal Disaster (1978) and The Flint Water Crisis (2014-2019). **Related activity**: *PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group.*	2
III	**Soil Pollution: Causes and Impacts**		**12**
	3.1	Definition and types of soil pollution: chemical, biological, and physical contaminants. Sources of soil pollution: industrial activities, agricultural practices, mining operations, and urbanisation.	2
	3.2	Pathways of soil contamination: direct release, atmospheric deposition, leaching, and runoff. Introduction to soil quality indicators and standards for assessing contamination levels.	3

	3.3	Overview of key pollutants: heavy metals, pesticides, petroleum hydrocarbons, and persistent organic pollutants (POPs).	2
	3.4	Ecological consequences of soil pollution: disruption of soil microbial communities, loss of biodiversity, and habitat degradation.	2
	3.5	Health risks associated with exposure to contaminated soils: Toxicological effects, food chain contamination, and respiratory diseases. Effects of soil contamination on ecosystem services.	2
	3.6	Case studies on long-term impacts of soil pollution on ecosystems and human populations. Example: Aral Sea Ecological Disaster, Agricultural Pesticide Pollution in Punjab, India and Mining Pollution in the Niger Delta, Nigeria. **Related activity***: PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group.*	1
IV	**Noise Pollution: Causes and Impacts**		**12**
	4.1	The definition and types of noise pollution are environmental, occupational, and transportation noise. Sources of noise pollution are industrial activities, transportation systems, construction sites, and recreational activities.	3
	4.2	Measure and assess noise levels: Decibel scale, sound monitoring equipment, and noise mapping techniques. Noise Pollution Standards and Legal Framework.	2
	4.3	The effects of noise pollution on human health include hearing loss, sleep disturbances, stress-related disorders, and cardiovascular diseases. (Discussion mode of learning can be adapted). **Related activity***: PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group.*	2
	4.4	The impact of noise pollution on wildlife behaviour, communication, and habitat disruption. Introduction to noise exposure limits and guidelines for protecting human health and wildlife.	3
	4.5	Case studies illustrating noise pollution's health and ecological consequences in different contexts. Examples: The Effects of Aircraft Noise on Heathrow Residents (London, UK) The Impact of Shipping Noise on Marine Life (Global Context) Urban Noise Pollution and its Effects on Songbirds (Urban Areas, Global Context). **Related activity**: *PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group.*	2
V	**Light Pollution: Causes, Ecological and Health Impacts**		**12**

	5.1	Definition and types of light pollution: skyglow, glare, light trespass, and clutter. Introduction to the concept of dark-sky preservation and its importance for ecosystems and human health.	3
	5.2	Sources of light pollution and measurement: outdoor lighting fixtures, streetlights, advertising signage, and industrial facilities, as well as methods for quantifying its extent and intensity.	2
	5.3	Artificial light at night (ALAN) affects wildlife behaviour, migration patterns, and ecosystems.	2
	5.4	The impact of light pollution on nocturnal species is disruption of circadian rhythms, predation risk, and habitat fragmentation.	1
	5.5	The health effects of light pollution on humans include sleep disturbances, hormonal imbalances, and an increased risk of chronic diseases.	2
	5.6	Case studies illustrate light pollution's ecological and health consequences in different ecosystems and urban areas. The Impact of Artificial Light on Sea Turtle Hatchlings (Coastal Areas, Global Context), The Effects of Urban Light Pollution on Nocturnal Insects (Urban Areas, Global Context),The Health Effects of Blue Light Exposure from LED Streetlights (Urban Areas, Global Context). **Related activity***: PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group.*	

References:

1. Boubel R.W., D.L. Fox, and A.C. Stern 1994. Fundamentals of Air pollution. Academic Press, NY,. Company Ltd.
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5. Dhaji 1996. The Text Book of Soil Science. Media Promoters and Publishers Pvt. Limited.
6. Harry O. 1922. Buckman The Nature and properties of soil. Macmillan,
7. Helmut Kohuke 1968. Soil physics. McGraw-Hill.
8. Krishnan Khannan, S. 1994. Fundamentals of Environmental Pollution, Chand Publication.
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12. Masters G.M. 2003. Introduction to Environmental Engineering and Science, , Prentice-Hall of India, New Delhi.
13. Mishra P.C. Soil Pollution and soil organisms, APH Publishing Corporation.
14. Nathensan, John 1986. Basic Environmental Technology - Wiley.
15. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.

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19. Sharma, B.K and H. Kaur (1994). Soil and Noise Pollution. Goel Publishing House, Meerut.
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23. Trivedi P.R. 1992. Environmental Agricultural pollution. Akashdeep Publishing House.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand air pollution, encompassing its concepts, sources, and effects on human health, animals, and vegetation, alongside the ability to analyse Pollution-related phenomena and evaluate associated threats and challenges through case studies.	U, R, An	PSO-1, 2, 3, 7
CO-2	Acquire in-depth knowledge of water pollution, covering natural water characteristics, potable water sources, international and industrial water quality standards, classification of pollution types, pollutant fate assessment, and critical evaluation of case studies on management strategies and emerging challenges in pollution control.	U, R, An	PSO-1, 2, 3, 7
CO-3	Grasp in soil pollution, covering its causes, impacts, and key pollutants. This will enable them to proficiently identify pollution sources, contamination pathways, ecological and health risks, and analyse long-term implications through case studies to support informed decision-making in soil management and remediation efforts.	U, AP, An	PSO-1, 2, 3, 7
CO-4	Gain a thorough understanding of noise pollution, encompassing its causes, effects, and measurement techniques. This will allow them to evaluate its impact on human health and wildlife behaviour and critically assess noise pollution standards and legal frameworks.	U, AP, An	PSO-1, 2, 3, 7
CO-5	Understand light pollution, encompassing its origins, ecosystem effects, and human well-being. They will be proficient in identifying sources, measuring intensity, and assessing impacts on nocturnal species, empowering them	U, AP, An	PSO-1, 2, 3, 7

	to advocate for dark-sky preservation and sustainable lighting practices using case studies.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Environmental Science II- Environmental Pollution

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand air pollution, encompassing its concepts, sources, and effects on human health, animals, and vegetation, alongside the ability to analyse pollution-related phenomena and evaluate associated threats and challenges through case studies.	PO1,6,8/ PSO-1, 2, 3, 7	U, An	F, C, P	L	-
2	Acquire in-depth knowledge of water pollution, covering natural water characteristics, potable water sources, international and industrial water quality standards, classification of pollution types, pollutant fate assessment, and critical evaluation of case studies on management strategies and emerging challenges in pollution control.	PO1, 6, 8/ PSO-1, 2, 3, 7	U, An	F, C	L	-
3	Grasp in soil pollution, covering its causes, impacts, and key pollutants. This will enable them to proficiently identify pollution sources, contamination pathways, ecological and health risks, and analyse long-term implications through case studies to support informed decision-making in soil management and remediation efforts.	PO1, 6, 8/ PSO-1, 2, 3, 7	U, An	F, C	L	-

4	Gain a thorough understanding of noise pollution, encompassing its causes, effects, and measurement techniques. This will allow them to evaluate its impact on human health and wildlife behaviour and critically assess noise pollution standards and legal frameworks.	PO1, 6, 8/ PSO-1, 2, 3, 7	U, Ap, An	F, C	L	-
5	Understand light pollution, encompassing its origins, ecosystem effects, and human well-being. They will be proficient in identifying sources, measuring intensity, and assessing impacts on nocturnal species, empowering them to advocate for dark-sky preservation and sustainable lighting practices using case studies.	PO1, 6, 8/ PSO-1, 2, 3, 7	U, Ap, An	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	2	3	1	-	-	-	1	1	-	-	-	-	2	-	3
CO 2	1	3	1	-	-	-	2	2	-	-	-	-	1	-	3
CO 3	1	2	2	-	-	-	2	1	-	-	-	-	2	-	3
CO 4	1	2	3	-	-	-	1	1	-	-	-	-	2	-	3
CO 5	1	3	2	-	-	-	2	1	-	-	-	-	2	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low

2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:

Suggested Assignments (Any two)

1. Effects of air pollution on human health
2. The health effects of light pollution on humans
3. Effects of noise pollution on human health
4. Risks associated with exposure to contaminated soils
5. Overview of key pollutants
6. Sources of water pollution

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Industrial/Field Visit Reports
4. Submission of Activity Reports
5. Tests
6. Quiz/Debate
7. Poster preparation & presentation

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	-	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓		-	-

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4VACZOO201**				
Course Title	**Communication and Popularisation of Life Sciences**				
Type of Course	**VAC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Pass in class XII				
Course Summary	This course equips the students with essential knowledge and skills for effectively communicating life sciences topics to diverse audiences. Through exploration of various scientific information sources and communication platforms, participants learn to utilize written, oral, visual, and digital modes for public engagement and outreach. Emphasis is placed on structured scientific writing, hypothesis preparation, and presentation strategies to ensure effective communication to both expert and non-expert audiences, with practical skills honed through workshops and practice sessions.				

Detailed Syllabus

Module	Unit	Content	30 hrs
I		**Introduction to Life Sciences**	**5**
	1.1	Definition, Branches, Scope and Significance of Life Sciences	2
	1.2	Organizations promoting Life Science - Employment opportunities – CSIR, ICAR, ICMR, DST, DBT, MoES, MoEF, IISER, ISRO (Brief Description)	3

II	**Sources of Scientific (Life Sciences) Information**		**5**
	2.1	Offline platforms– Peer reviewed Journal articles (Mention Predatory Journals), reviews, conference proceedings, edited books, Policy documents, official reports (official govt. or public agency and NGO sources), Recorded speeches (TED Talks), Encyclopaedia, Magazines, Press releases and Seminars.	3
	2.2	Online Platforms- Google Scholar, Research gate, Pubmed and Scopus.	2
III	**Tools and techniques of Life Science Communication & Public Sensitisation**		**12**
	3.1	Different modes of life science communication: written, oral, visual, and digital.	3
	3.2	Science outreach for biodiversity conservation: Flash mobs, dramas, street play, documentaries, public awareness talks, exhibitions, science journalism and advertisements.	3
	3.3	Online Science Communication- social media, websites, blogs, podcasts and You tube.	3
	3.4	Science Communication during disasters: Public engagement with science and technologies-Weather alert- INCOIS, NDMA, Kerala State Disaster Management Authority and GDACS (Brief explanation).	3
IV	**Writing for Life Sciences**		**4**
	4.1	Structure and components of scientific papers: introduction, materials and methods, results, discussion, conclusion and Reference; Hypothesis - preparation for a research problem.	1
	4.2	Writing clear and concise scientific prose	1
	4.3	Literature review and citation practices	1
	4.4	Tips for effective scientific writing: avoiding plagiarism, ensuring clarity, and precision	1
V	**Presenting Scientific Research**		**4**
	5.1	Principles of effective oral presentations: organization, delivery, using posters and visual aids	1
	5.2	Communicating complex scientific concepts to non-expert audiences/public	1
	5.3	Handling questions and engaging the audience during presentations.	1
	5.4	Presentation skills; workshops and practice sessions	1

References:

1. Borchardt, J. K. (2019). Communicating Science: A Primer for Working with the Media. Island Press.
2. Cambridge University Press.
3. Engineering Communication. MIT Press, UK.
4. Gigante, E. Marie (2018). Introducing Science Through Images: Cases of Visual Popularization (Studies in Rhetoric/Communication), University of South Carolina P
5. Gregory, J., & Miller, S. (2015). Science in Public: Communication, Culture, and Credibility. Basic Books
6. Holliman, R., Whitelegg, E., Scanlon, E., Smidt, S., & Thomas, J. (Eds.). (2009). Investigating Science Communication in the Information Age: Implications for Public Engagement and Popular Media. Oxford University Press.
7. James G, Paradis and Muriel L. Zimmerman (2002). The MIT Guide to Science and Engineering Communication, Second Edition, The MIT press Publishers, 336pp.
8. Kothari. C.R (2023) Research Methodology. Methods and Techniques. New Age International (P) Limited, Publishers, New Delhi.
9. National Academy of Sciences, National Academy of Engineering, & Institute of Medicine. (2006). Communicating Science Effectively: A Research Agenda. National Academies Press.
10. Nicholas Russel (2009). Communicating Science: Professional, Popular, Literary. Cambridge University Press, 1st edition.
11. Ramesh, A. (2019). Science Communication: A Practical Guide for Scientists. Indian Academy of Sciences.

Web Resources:

1. https://www.aaas.org/programs/public-engagement/communicating-science-online
2. https://www.scidev.net/global/communication/
3. https://www.science.org/
4. https://www.ted.com/topics/science+communication
5. https://theconversation.com/us/science

Practicum (30 hrs)

Sl. No.	Contents
1	Prepare a documentary / You tube video links on various disasters/ Pollution
2	Conduct a flash mob/ Drama to address any environmental issue.
3	Prepare scientific talks for the public on relevant topics on Life Science. **OR** Write Scientific papers on any topic related to life Science.
4	Plagiarism checking of the given scientific report and documenting using a suitable software. **OR** Preparation of posters / sign boards for giving awareness to public on any relevant topic related to life science

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO1	Understand the definition and scope of life sciences and identify key organizations promoting life science research and development.	U	PSO1
CO2	Analyse the different sources of life science information, both online and offline platforms.	An	PSO2
CO3	Identify and evaluate different communication channels utilized in life sciences.	U, E	PSO2
CO4	Understand the importance of public sensitization on life science issues and demonstrate proficiency in selecting and implementing appropriate communication channels based on target audience characteristics, message content, and communication objectives.	U, Ap	PSO7
CO5	Utilize digital and social media platforms to disseminate scientific information and engage with the public.	Ap, C	PSO7
CO6	Write scientific papers, reports, and proposals suitable for both scientific and lay audiences.	Ap, C	PSO2
CO7	Deliver informative presentations of scientific research to diverse audiences on any relevant topic on life science.	Ap	PSO3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Communication and Popularisation of Life Sciences
Credits: 2:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Understand the definition and scope of life sciences and identify key organizations promoting	PO1, PSO1	U	F, C	L	

	life science research and development.					
2.	Analyse the different sources of life science information, both online and offline platforms.	PO1, PSO2	An	F, C	L	P
3.	Identify and evaluate different communication channels utilized in life sciences.	PO1, PSO2	U, E	C	L	P
4.	Understand the importance of public sensitization on Life science issues and demonstrate proficiency in selecting and implementing appropriate communication channels based on target audience characteristics, message content, and communication objectives.	PO1, PO2 PSO7	U, Ap	F	L	P
5.	Utilise digital and social media platforms to disseminate scientific information and engage with the public.	PO6, PO7 PSO7	Ap, C	P		P
6.	Write scientific papers, reports, and proposals suitable for both scientific and lay audiences.	PO4, PSO2	Ap, C	P		P
7.	Deliver informative presentations of scientific research to diverse audiences on any relevant topic on life science.	PO4, PO 5 PSO3	Ap	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	PSO 2	PSO 3	PSO4	PSO 5	PSO 6	PSO 7	PO1	PO 2	PO3	PO4	PO5	PO6	PO7	PO 8
CO 1	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 2	-	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 3	-	2	-	-	-	-	-	1	-	-	-	-	-	-	-
CO 4	-	-	-	-	-	-	2	1	2	-	-	-	-	-	-
CO 5	-	-	-	-	-	-	1	-	-	-	-	-	2	3	-
CO 6	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-
CO 7	-	-	3	-	-	-	-	-	-	-	3	2	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment /Seminar topics

1. Compilation of TED talks.
2. Organizations promoting Life Sciences.

3. Finding Research Gaps using library resources.
4. Modes of Life Science Communication.
5. Role of social media for Life science Communication
6. Effective scientific writing
7. Scientific poster / chart preparation/ oral presentation.

Continuous Comprehensive Assessment

1. Quiz/ Debates
2. Assignment
3. Submission of report
4. Group discussion
5. Test
6. Open Book

End Semester assessment

1. Multiple choice question
2. Very short answer questions
3. Short answer questions
4. Practical Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		
CO 4		✓		✓
CO 5		✓		✓
CO 6		✓		
CO7		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4VACZOO202**				
Course Title	**Bioeconomics and Ecotourism**				
Type of Course	**VAC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	3 hours	-	0	3
Pre-requisites	Pass of Class XII				
Course Summary	The course provides an interdisciplinary exploration of the intersections between biology, economics, and tourism and understanding their significance in promoting sustainable use of natural resources and conservation of biodiversity. Students learn about the economic principles underlying the management of biological resources, including concepts such as supply and demand, externalities, market failures, and resource allocation. Students explore the practices of ecotourism as a conservation tool, and analyze case studies and examples from the Indian and Kerala context. Course discusses the current challenges and issues in bioeconomics and ecotourism, such as climate change, invasive species, over tourism, and socio-economic inequalities, and explores potential solutions and future directions for research and practice.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Basics of Bioeconomics**	**10**
	1.1	Bioeconomics-Definition, Concept and scope, Economic theories applied to biodiversity conservation; Key principles of Bioeconomics- Optimal resource management, Ecosystem goods (Tangible), Services (Intangible) and Externalities.	3
	1.2	Bioresource economics- Types- Natural resource economics (Tragedy of the commons and resource depletion, Property rights and common-pool resources), Fisheries Economics (Fisheries management and overfishing, Sustainable fisheries and marine conservation) and Forestry Economics (Timber harvesting and forest management). Economic valuation of forest	2

		ecosystem services, Sustainable forestry practices and certification- Brief description.	
	1.3	Ecosystem Services- Provisioning Services (Food, water, fuel and wood), Supporting services (Nutrient cycling, Soil formation, Primary production and habitat provision), Regulating Services (Climate regulation, Flood regulation and disease) and Cultural services (Aesthetic, recreational and recreational values).	3
	1.4	Externalities-Types (Positive, negative, Environment and Technological) and Implications (Market failure, Efficiency loss and Regulatory Interventions).	2
II	**Trends in Bioeconomics and Policies**		**8**
	2.1	Green Economy- Biotechnology based economics, Environmental economics and Ecological economics.	2
	2.2	Methods for assessing the economic value of biodiversity and ecosystem services- Standard market prizes, Benefit cost ratio, Net present value, Present value ratio.	2
	2.3	Green production and sustainable consumption, Ecological Footprint.	2
	2.4	Policy implications of economic valuation for biodiversity conservation in India. Resource use incentives and property rights, private, common and public property rights and limitations, defendable right to resources.	2
III	**Ecotourism and Sustainable Development**		**14**
	3.1	Definition, Scope and Principles of Ecotourism, Role of Ecotourism in conservation and sustainable development.	4
	3.2	Ecotourism planning and management strategies; Community-based ecotourism initiatives in India with special reference to Kerala.	4
	3.3	Major Ecotourism centres of Kerala - Kuruva, Thenmala, Gavi, Adavi and Ponmudi. **Related activity –***Visit to Ecotourism centers and submit a short report with photos.*	6
IV	**Impacts of Ecotourism on Biodiversity and Communities**		**6**
	4.1	Impacts of ecotourism: Ecological (habitat disturbance, wildlife disturbance, pollution), Socio-cultural (Indigenous tourism, Cultural preservation, impacts of ecotourism on local communities); Economic (benefits and opportunities) and Environmental. **Related activity-***Recording of Invasive species in the Ecotourist regions at the time of study visit.*	4
	4.2	Issues and Challenges- Invasive species, CO_2 emissions, water pollution, Biodiversity loss.	2
V	**Policies and Management for Sustainable Ecotourism**		**7**

	5.1	National and international policies and regulations governing ecotourism.	2
	5.2	Role of government agencies, NGOs and local communities in ecotourism management. Strategies for mitigating negative impacts and enhancing the benefits of ecotourism in India.	2
	5.3	Marketing Ecotourism- Definition, concepts and features: Brief account. **Related activity**-*Marketing of beneficial products from forest.*	3

References:

1. Ghate, R., and Ghate, P. (Eds.). (2017) Ecotourism in India: Experiences, Approaches, and Challenges. Springer.
2. John M Gowdy and Sabine O'Haro (1999) The Science of Managing Resources.
3. Karanth, K. K., and Madhusudan, M. D. (Eds.). (2002) Living with Wildlife: Wildlife Resource and Livelihoods in South Asia. Permanent Black.
4. Lars Ravensbeck, Niels Vestergaard and Jens Wustemann (2019) "Bioeconomic modelling and Valuation of Exploited Marine Ecosystem".
5. Nautiyal, S., Kaechele, H., & Rao, K. S. (Eds.). (2016) Transdisciplinary perspectives on Transitions to Sustainability. Springer.
6. Nyaupane, G. P., and Poudel, S. (Eds.). (2011) Community-Based Ecotourism: Perspectives and Case Studies. CABI.
7. World Tourism Organization (UNWTO) (2015) Global Report on Adventure Tourism. UNWTO.

Web Resources:

1. https://cedindia.org/
2. https://rtsoi.org/
3. https://indiabiodiversity.org/
4. https://www.moef.gov.in/
5. https://www.tourism.gov.in/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop a foundational understanding of bioeconomics as an interdisciplinary field that integrates principles from biology and economics and able to analyze bioresource markets, including those for renewable resources.	U, An	PSO-1,2
CO-2	Understanding of the concept of ecosystem services, including provisioning, regulating, supporting, and cultural services and acquiring skills in economic valuation methods.	U, E	PSO-1,3

CO-3	Understanding of the latest trends and developments in bioeconomics and related policies and analyzing the impact of globalization, trade liberalization, and international agreements on bioeconomic sectors and policies.	U, An	PSO-1,2
CO-4	Understand the principles and concepts of ecotourism.	U	PSO-1
CO-5	Engage in critical thinking exercises and problem-solving activities to analyse real-world ecotourism challenges, such as balancing conservation and economic development objectives, addressing social inequalities.	C, An	PSO-.2
CO-6	Identify positive impacts of ecotourism on biodiversity and communities and evaluate existing ecotourism policies, regulations, and management practices in addressing biodiversity and community impacts.	R, U, E	PSO-1,2,3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Bioeconomics and Ecotourism
Credits: 3:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Develop a foundational understanding of bioeconomics as an interdisciplinary field that integrates principles from biology and economics and able to analyze bioresource markets, including those for renewable resources.	PO 1/ PSO-1,2	U, An	F, C	L	-
2.	Understanding of the concept of ecosystem services, including provisioning, regulating, supporting, and cultural services and acquiring skills in economic valuation methods.	PO 2/ PSO-1, PSO 3	U, E	P	L	-
3	Understanding of the latest trends and developments in bioeconomics and related	PO 1/ PSO-1, PSO 2	U, An	F, C	L	-

	policies and analysing the impact of globalization, trade liberalization, and international agreements on bioeconomic sectors and policies.					
4.	Understand the principles and concepts of ecotourism.	PO1/ PSO-1	U	P	L	-
5	Engage in critical thinking exercises and problem-solving activities to analyse real-world ecotourism challenges, such as balancing conservation and economic development objectives, addressing social inequalities.	PO1/PSO-2	C, An	F, C	L	--
6	Identify positive impacts of ecotourism on biodiversity and communities and evaluate existing ecotourism policies, regulations, and management practices in addressing biodiversity and community impacts.	PO2/ PSO-1, PSO 2, PSO 3	R, U, E	P	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO 8**
CO 1	1	2	-	-	-	-	2	-	-	-	-	-	-	--
CO 2	2	-	3	-	-	-	-	2	-	-	-	-	-	-
CO 3	3	2	1	-	-	-	3	-	-	-	-	-	-	-

CO 4	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 5	2	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 6	2	1	3	-	-	-	-	3	-	-	-	-	--	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignments / Seminar topics/Field study reports

1. Principles of bioeconomics
2. Economic impact assessment of a major ecotourism event
3. Make sustainable tourism marketing plan for a destination area or ecotourism enterprise
4. Prepare a report on the study of a selected resource, including its ecological characteristics, biodiversity, productivity, and socio-economic importance.
5. Environmental management measures to minimize the ecological footprint of ecotourism activities.
6. Major Ecotourism centres of Kerala.
7. Prepare a study report after visiting a nearby ecotourism centre.

Continuous and Comprehensive Assessment

1. Quiz / Debate
2. Assignment
3. Group Discussion
4. Seminar
5. Submission of report
6. Test

End Semester Assessment

1. Multiple Choice questions

2. Short answer questions
3. Essay questions

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6		✓		

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK4SECZOO201**				
Course Title	**Livestock Management**				
Type of Course	**SEC**				
Semester	IV				
Academic Level	200 - 299				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Pass in Class XII				
Course Summary	This course provides a comprehensive understanding of livestock management, covering aspects from breeding and nutrition to disease control, funding opportunities, and business ventures in the livestock industry. It emphasizes breeds of cattle, poultry, sheep, and goats, along with major diseases and preventive measures. Students are guided on training centres, national research institutes, registration, insurance, and commercialization opportunities. Emerging trends such as farm tourism and start-ups in livestock management are also highlighted, providing a comprehensive overview for aspiring livestock managers. It equips learners with practical knowledge and skills necessary for successful livestock farming and management.				

Detailed Syllabus

Module	Unit	Content	30 hrs
I		**Introduction to Livestock**	**2**

	1.1	Scope of Livestock Industry; Livestock- Dairy and Poultry; Value added products of Live stock	2
II	**Nutritional requirements**		**5**
	2.1	Dietary needs for Dairy and Poultry: Carbohydrates, Fats, Protein, Minerals, Vitamins and Water. Permitted feed additives and Advanced Ration Formulations for dairy and poultry (Brief description).	5
III	**Maintenance of Livestock**		**8**
	3.1	Selection of Livestock (High quality milk and meat breeds of Cattle and Broilers and Layers of Poultry).	1
	3.2	**Breeds of Fowl** (Brief description): Indigenous (Aseel, and Kadaknath) and Exotic breeds -Asiatic (Brahma), English (Orpington), Mediterranean (White Leghorn) and American class (Rhode Island Red) **Breeds of Duck**: Nageswari, Kuttanad breed and Indian runner **Breeds of Turkey**: Broad breasted Bronze **Breeds of quails:** Japanese breed	2
	3.3	**Breeds of cattle**: (Brief description): Indigenous (Vechur cow, Kasaragod dwarf and Red Sindhi: Exotic (Jersey and Brown Swiss) **Breeds of Sheep**: Barbari and Deccani. **Breeds of Goat**: Malabari and Jamunapari.	2
	3.4	Breeding, Rearing and Housing of Cattle and Poultry.	3
IV	**Livestock Diseases and Management**		**5**
	4.1	Major Diseases of Poultry: (Coccidiosis, Pullorum, Fowl pox) and Cattle (Anthrax, Tuberculosis, Foot and Mouth Disease): Symptoms and Preventive measures (Mention-Vaccination and deworming programmes); Biosecurity.	5
V	**Beginner's guide**		**10**
	5.1	Funding agencies: Kerala State Start-up Mission, Government Agencies, Banks, Co-operative Societies, NGOs, NRLM, Ksheerasagaram and "Adu-gramam" and 'A-Help' Programme (Brief description).	2
	5.2	Training Centres: Kerala Livestock Development Board, Indo-Swiss Farm -Mattupetti, Live -stock Research Station- Palakkad, KVASU - Wayanad, College of Veterinary and Animal Sciences (CVAS) - Mannuthy, Department of Animal Husbandry and College of Agriculture	2

		- Vellayani Central Poultry Development Organization and Training Institute-Bangalore (Brief description).	
	5.3	National Research Institutes: NDRI, CIRC, CIRG, NIVEDI and CARI (Brief description).	1
	5.4	Registration and Insurance: (Purpose and Benefits): Department of Animal Husbandry and Dairying Development- Govt. of Kerala, National Livestock Mission, National Gokul Mission (Brief description).	2
	5.5	Commercialization of Livestock Products: KEPCO and MPI (Brief description)	1
	5.6	Emerging Trends in Livestock Management: Start-ups- Farm Tourism.	2

References

1. Aruna T. Kumar (2008). Handbook of Animal Husbandry, published by ICAR.
2. Banerji, G.C. A textbook of Animal husbandry, 1998. Oxford & IBH.
3. ICAR. Handbook of Animal Husbandry, 2013. Indian Council of Agriculture Research Krishi Bhavan.
4. Malti, S.K, Gendley. M.K, Shahaji Phand (2021). Approaches for improving Livestock Productivity through Nutrition and Animal Health Management. Jointly published by SAU-DSVCKV, Durg C.G and MANAGE, Hyderabad.
5. Peter D. Constable, Kenneth W. Hinchcliff, and Stanley H. Done (2016).
6. Veterinary Medicine: A Textbook of the Diseases of Cattle, Sheep, Pigs, Goats and Horses
7. Richard.O.Kellims and David. C. Church (2009). Livestock Feeds and Feeding (6th Edition).
8. Sasthry N.S.R and C.K. Thomas (2019). Live Stock Production Management, Kalyani Publishers, New Delhi.
9. Taylor, R. E and Field, T.G. (2004). Scientific Farm Animal Production: An introduction to Animal Science. Prentice-Hall.

Web Resources:

1. https://www.agriinfo.in/
2. https://icar.org.in/
3. https://www.iva.org.in/
4. https://www.ivri.nic.in/
5. https://krishikosh.egranth.ac.in/
6. https://www.manage.gov.in/
7. https://www.nddb.coop/
8. https://www.ndri.res.in/
9. https://www.nianp.res.in/
10. http://www.veterinaryindia.net/

Practicum (30 hrs)

Sl. No.	Contents
1.	Identification of Indigenous and Exotics breeds of Live stocks.
2.	Visit to Poultry farm /Dairy Centres and Submit a report with Photos **OR** Visit to Institutes / Labs (Any one) **OR** Visit to a nearby Milk Co-operative Society, prepare a Quality register by using lactometer
3.	Analysis of quality of Milk- Casein/ Methylene Blue Reductase test.
4.	Survey on the Challenges faced by poultry and dairy farmers. **OR** Visit a Farm Tourism Centre and submit a detailed report.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO1	Comprehend the scope and significance of the livestock industry and gain knowledge about value-added products derived from livestock and their economic importance.	U	PSO1
CO 2	Understand the essential nutrients required for optimal growth and health in dairy and poultry animals including carbohydrates, fats, proteins, minerals and vitamins and analyse the importance of feed additives and advanced ration formulations in different livestock species and stages.	U, An	PSO2
CO3	Understand and evaluate the selection criteria for high-quality milch and meat breeds of livestock, along with proper facilities, equipment, and housing requirements.	U, E	PSO2
CO4	Gain insights into funding opportunities, training programs, registration, insurance options, and commercialization avenues related to livestock farming and start-ups like farm tourism.	U, Ap	PSO7
CO5	Serve as an animal husbandry compendium for young entrepreneurs.	Ap, C	PSO6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Live Stock Management
Credits: 2:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Comprehend the scope and significance of the livestock industry and gain knowledge about value-added products derived from livestock and their economic importance.	PO1/ PSO1	U	F	L	-
2	Identify the essential nutrients required for optimal growth and health in dairy and poultry animals including carbohydrates, fats, proteins, minerals and vitamins and analyse the importance of feed additives and advanced ration formulations in different livestock species and stages.	PO2, PO6/ PSO2	U, An	F, C	L	-
3	Understand and evaluate the selection criteria for high-quality milch and meat breeds of livestock, along with proper facilities, equipment, and housing requirements.	PO2, PO6/ PSO2, PSO5	U, E	C, P	L	-P
4	Gain insights into funding opportunities, training programs, registration, insurance options, and commercialization avenues related to livestock farming and start-ups like farm tourism.	PO5, PO6, / PSO7	U, Ap	P	-	P
5	Serve as an animal husbandry compendium for young entrepreneurs.	PO5, PO6/ PSO6	U, C	P	-	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 2	-	1	-	-	-	-	-	-	-	1	-	-	-	2	-	-
CO 3	-	1	-	-	-	-	-	-	-	2	-	-	-	3	-	-
CO 4	-	-	-	-	2		1	-	-	-	-	-	3	3	-	-
CO 5	-	-	-	-		2	1	-	-	-	-	-	2	3	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics

1. Prepare a chart showing dietary requirements of poultry.
2. Genetic breeds of Dairy.
3. Photography charts of Poultry.
4. Diseases of Dairy/ Poultry.
5. Incidence and effects of Bird flu in Kuttanadu.
6. Make a Short documentary on Farm Tourism.
7. Submission of any two-value added by -products.
8. Funding agencies and training centres for Livestock management.

Continuous Comprehensive Assessment

1. Quiz/ Debate
2. Assignment
3. Group discussion
4. Submission of Report
5. Test

End Semester assessment

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Practical Exam.

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		

SEMESTER V

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5DSCZOO301**				
Course Title	**Developmental Biology**				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	Developmental biology explores the intricate processes governing organisms' growth, differentiation, and morphogenesis from conception to maturity. Key topics in this course include historical perspectives, gametogenesis, fertilization, fate mapping, potency, and regeneration. Advanced concepts such as prenatal diagnostics, in vitro fertilization, and cryopreservation are also covered. Through lectures, labs, and activities, students gain a deep understanding of developmental principles and their relevance to human health. Emphasis is placed on critical thinking and interdisciplinary approaches, preparing students for diverse career paths in research, medicine, biotechnology, and education.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Introduction to developmental biology**		**6**
	1.1	Historical perspectives: Theories - Preformation, Epigenesis, Recapitulation and Germplasm (Brief account only).	1
	1.2	Gametogenesis: Spermatogenesis and Oogenesis, Structure of sperm and egg.	4
	1.3	Egg: Definition. Egg envelopes. Classification of eggs (Based on the presence or absence of shell, amount of yolk, distribution of yolk, and pattern of development).	1

II	**Early Embryonic Development**		**11**
	2.1	Process of Fertilization: Agglutination, Acrosome reaction, Activation of egg, Amphimixis. Polyspermy: Primary and secondary block to polyspermy.	5
	2.2	Cleavage: Patterns and types of cleavage (Holoblastic and meroblastic).	3
	2.3	Blastulation (Brief account only), Types of Blastula.	1
	2.4	Fate Map and its significance, Construction of Fatemap - Mention different techniques (Vital staining, Radioactive labelling, Genetic marking), Fate map of the frog.	2
III	**Late Embryonic Development**		**13**
	3.1	Concept of gastrulation. A brief account of morphogenetic movements: Epiboly and Emboly (Invagination, Involution, Infiltration, Ingression, Delamination, Convergence, Divergence).	2
	3.2	Gastrulation in frogs.	3
	3.3	Gastrulation in Chick, Salient features of 24 hr Chick embryo.	3
	3.4	Concept of germ layers, Derivatives of germ layers (Ectoderm, Endoderm and Mesoderm).	1
	3.5	Extra-embryonic membranes in chick.	1
	3.6	Development of Man - Implantation, Pregnancy (Brief account only).	1
	3.7	Placentation in mammals: Functions of the placenta, Classification (based on the type of foetal membranes, mode of implantation, nature of the contact, distribution of chorionic villi and histological intimacy).	2
IV	**Implications of Developmental Biology**		**6**
	4.1	Concept of Potency in embryonic cells: Totipotency, Pluripotency, and Unipotency. Mention the role of stem cells in post-embryonic development.	1
	4.2	Determination and differentiation in embryonic development. Genes involved in development (Brief account only).	1
	4.2	Significance of organizer and embryonic induction (Brief account only). Mention the Spemann-Mangold experiment.	1
	4.3	Regeneration: Modes of regeneration (Epimorphosis, Morphollaxis and Compensatory regeneration with one example from each).	1
	4.4	Teratology: Teratogenic agents (Drugs and chemicals, Infectious agents like viruses and bacteria, Ionizing radiations, Metabolic imbalance, Malnutrition) and their effect on embryonic development (Brief account only).	1

	4.5	Parthenogenesis: Definition. Natural (Arrhenotoky and Thelytoky, (Obligatory and Facultative) and Artificial parthenogenesis. Significance of parthenogenesis (Brief account only).	1
V	**Advancements in Developmental Biology**		**9**
	5.1	Prenatal diagnostic techniques: Amniocentesis, Alpha-Foetal Protein (AFP) estimation, Chorionic villus sampling, and Ultrasound scanning.	4
	5.2	*In vitro* fertilization and embryo transfer in humans and test tube babies.	2
	5.3	Assisted Reproductive Techniques: GIFT, ZIFT, TET, ICSI (Brief account only).	2
	5.4	Cryopreservation of gametes and embryos: Explain techniques. Implications and legal implications (Brief account only).	1

References

1. Michael J.F. Barresi and Scott F. Gilbert (2020). Developmental Biology, OUP USA; 12th edition.
2. Jonathan M.W. Slack and Leslie Dale (2021). Essential Developmental Biology. Wiley-Blackwell, 4th edition.
3. Gilbert, S.F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
4. Balinsky B.I. and Fabian B.C. (2006). An Introduction to Embryology. VIII Edition, International Thompson Computer Press.
5. Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.

Suggestive Reading

1. Kay Elder and Brian Dale (2020). In-Vitro Fertilization. Cambridge University Press; 4th edition.
2. Subramanian M.A. Developmental Biology, M J P Publisher; First Edition (1 November 2021).
3. Kalthoff, K. (2001) Analysis of Biological Development. II Edition, McGraw Hill Publishers.
4. Arora, R. and Grover, A. (2018). Developmental Biology: Principles and Concepts. I Edition, R Chand & Company.
5. Berry, A. K. (2008). An Introduction to Embryology. Emkay Publications.
6. Goel, S.C. (1984). Principles of animal developmental biology. Himalaya Publ. House, Bombay.
7. Verma, P.S. & Agarwal V.K. (2010). Chordate Embryology. S. Chand & Company Ltd.
8. Varsha Baweja and Monica Misra (2021). Practical Manual of Developmental Biology, ebook.

Practicum (30 hrs)

Sl. No	Contents
1	Sketch and label the Vertical Section (VS) of the egg of a hen - Use Slide/Model/Picture (Spotter).
2	Sketch and label frog blastula - Use Slide/Model/Picture (Spotter).

3	Sketch and label frog gastrula - Use Slide/Model/Picture (Spotter).
4	Sketch and label human egg cell - Use Slide/Model/Picture (Spotter).
5	Sketch and label the fate map of the frog - Use Slide/Model/Picture (Spotter)
6	Mounting, sketch and label of 24hrs chick blastoderm (Demonstration & Spotter).
7	*in vivo* study of chick embryo development by windowing and candling methods (Demonstration).
8	Study of indirect development and metamorphosis by rearing Drosophila (Demonstration).
9	Sketch and label a Human placenta, mention its type, and its functions - Use Slide/Model/Picture /specimen (Spotter).
10	Sketch and label a Sheep placenta, mention its type, and its functions - Use Slide/Model/Picture/specimen (Spotter).
11	Sketch and label a Pig placenta, Mention its type, and its functions - Use Slide/Model/Picture/specimen (Spotter).
12	Sperm motility in Zebra fish or any fish (Demonstration only).
13	Prepare a poster on the developmental stages of drosophila (Group activity).
14	Prepare a poster on the developmental stages of frogs (Group activity).
15	Prepare a poster on the developmental stages of a chick (18 hr, 24 hr, 36 hr and 48 hr) (Group activity).
16	Prepare a poster on different types of placenta: Epitheliochorial, Syndesmochorial, Endotheliochorial, and Haemochorial (Group activity).
17	Renowned embryologists around the world (Hans Spemann, Sir John Gurdon, Ian Wilmut) (Spotters).
18	Visit an IVF Centre and make a report on assisted reproductive techniques.
19	Make a poster presentation on different types of eggs (Group activity).
20	Conduct an awareness programme on Assisted Reproductive Techniques.
21	Conduct a debate on ethical issues related to human embryo research. Make a poster presentation on different types of eggs (Group activity).
22	Conduct an awareness programme on Assisted Reproductive Techniques.
23	Conduct a debate on ethical issues related to human embryo research.

References

1. Michael J.F. Barresi and Scott F. Gilbert (2020). Developmental Biology, OUP USA; 12th edition.
2. Verma, P. S. & Agarwal V.K. (2010). Chordate Embryology. S. Chand & Company Ltd.
3. Varsha Baweja and Monica Misra (2021). Practical Manual of Developmental Biology, ebook.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain insights into the historical journey of developmental biology and enhance comprehension of intricate developmental processes.	U	1, 2,6
CO-2	Enhance comprehension of the typical pattern and process of fertilization, as well as the sequential developmental stages throughout embryogenesis.	U	1, 2
CO-3	Develop expertise in observing vital staining techniques for tracing cell lineage in chick blastoderms and analyse and synthesize information from studies on frog, chick, and human embryology to establish connections between developmental processes and evolutionary biology.	U, An, Ap	1, 5, 6
CO-4	Comprehensive understanding of fundamental concepts in developmental biology, encompassing potency, organizers, regeneration, teratology, and parthenogenesis.	U, Ap	1, 2,4
CO-5	Gain a fundamental understanding and recognize the significance of stem cells, in vitro fertilization (IVF), and other assisted reproductive technologies.	U, Ap	1, 2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Developmental Biology

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
CO-1	Gain insights into the historical journey of developmental biology and enhance comprehension of intricate developmental processes.	PO- 1, 6/ PSO- 1, 2, 6	R, U	F, C	L	P
CO-2	Enhance comprehension of the typical pattern and process of fertilization, as well as the sequential developmental stages throughout embryogenesis.	PO-1/ PSO-1, 2	U	P	L	1
CO-3	Develop expertise in observing vital staining techniques for tracing cell	PO-1, 6/ PSO-1, 5,	U, An, Ap	C, P	L	P

	lineage in chick blastoderms and analyse and synthesize information from studies on frog, chick, and human embryology to establish connections between developmental processes and evolutionary biology.	6				
CO-4	Comprehensive understanding of fundamental concepts in developmental biology, encompassing potency, organizers, regeneration, teratology, and parthenogenesis.	PO-8/ PSO-1, 2, 4	U, Ap	F, C	L	
CO-5	Gain a fundamental understanding and recognize the significance of stem cells, in vitro fertilization (IVF), and other assisted reproductive technologies.	PO-1, 6, 8/ PSO-1, 2	U, Ap	C	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	2	2	-	-	-	1	-	1	-	-	-	-	2	-	-
CO 2	2	2	-	-	-	-	-	1	-	-	-	-	-	-	-
CO 3	2	-	-	-	2	1	-	1	-	-	-	-	2	-	-
CO 4	3	2	-	2	-	-	-	-	-	-	-	-	-	-	2
CO 5	3	2	-	-	-	-	-	1	-	-	-	-	2	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignments (Any two)

1. Explore the mechanisms of organogenesis in vertebrate development.

2. Discuss the role of environmental factors in influencing developmental processes.
3. Investigate the role of stem cells in tissue regeneration and embryonic development.
4. Explore the impact of teratogens on foetal development and congenital abnormalities.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of Field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	-	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	✓	-	✓

University of Kerala

Discipline	**Zoology**				
Course Code	**UK5DSCZOO302**				
Course Title	**Animal Physiology**				
Type of Course	**DSC**				
Semester	**V**				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course provides a comprehensive overview of essential topics in animal physiology, covering areas such as nutrition, obesity, respiratory physiology, blood composition, cardiovascular function, renal physiology, muscle physiology, nerve and sensory physiology, special senses, endocrinology, and reproductive physiology. Students will explore the mechanisms and functions of various physiological processes in animals, including the impacts of nutrition on health, respiratory adaptations in different environments, blood clotting disorders, cardiac muscle features, muscle contraction mechanisms, nerve impulse generation, sensory physiology, hormonal functions and disorders, and reproductive cycles.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Physiology of Nutrition and Respiration**	**8**
	1.1	Balanced diet, nutritional disorders: - Protein-energy malnutrition, Vitamin deficiency, Deficiency of iron, Iodine and Calcium.	2
	1.2	Obesity: - Causes and consequences, BMR and its significance, BMR measurement.	1

	1.3	Respiratory pigments, Transport of oxygen and carbon dioxide in blood.	2
	1.4	Dissociation curves and factors influencing the curve, Bohr effect and Haldane effect.	1
	1.5	Respiratory adaptations in high altitude and deep-sea diving (Brief accounts only).	1
	1.6	Respiratory disturbances: e.g. Apnoea, Dyspnoea, Hypoxia, Hypocapnia, Hypercapnia, Asphyxia, and Carbon monoxide poisoning (Brief account only).	1
II	**Circulatory Physiology**		**7**
	2.1	Blood composition and function.	1
	2.2	Haemostasis: - Extrinsic and intrinsic pathways, Anticoagulant - Endogenous and Exogenous. Disorders of blood clotting, e.g., Deep Vein Thrombosis, Pulmonary Embolism, and Arterial Thrombosis (Mention only), and Anticoagulants, e.g., Coumarins and Heparin (Mention only).	2
	2.3	Features of cardiac muscle fibre include intercalated disc and gap junction, Cardiac cycle, Origin and conduction of cardiac impulses, and heart sounds.	2
	2.4	Blood pressure, Electrocardiogram, Angiogram, Angioplasty. Cardiovascular abnormalities: e.g. Coronary Artery Disease, Cardiomyopathy, and congenital heart disease (Brief account only).	2
III	**Renal and Muscle Physiology**		**10**
	3.1	Mechanism of urine formation and osmoregulation, Concentration of the urine-counter current system.	2
	3.2	Osmoregulation in freshwater, marine, estuarine and terrestrial animals.	2
	3.3	Dialysis types, Kidney transplantation, Renal disorders, e.g., Nephritis, Haematuria, Renal calculi, Acidosis, and Alkalosis (Brief account only).	2
	3.4	Ultrastructure of skeletal muscle, Muscle proteins and molecular and chemical basis of muscle contraction, Sliding filament theory.	2
	3.5	Motor Unit, Simple muscle twitch, Summation, Tetanus, Tonus, all-or-nothing law, Fatigue, Oxygen debt, Rigor mortis.	1
	3.6	Muscle Dysfunction and Pathologies: e.g. Muscular Dystrophy, Myasthenia Gravis, Muscle Cramps, Muscle Strain, Muscle Spasms, and Muscle Atrophy (Brief account only).	1
IV	**Nerve and Sensory Physiology**		**11**
	4.1	Generation and propagation of nerve impulse	2
	4.2	Synaptic transmission: Electrical, Chemical and mixed. Neurotransmitters: Types, Function, Transport. Ionotropic and Metabotropic receptors, EEG.	2

	4.3	Neurodegenerative disorders: e.g. Alzheimer's Disease, Parkinson's Disease, Huntington's Disease, Multiple sclerosis, and Dementia (Brief account only).	1
	4.4	Physiology of vision, Visual elements and pigments, Photochemistry of vision. Eye defects: e.g. Myopia, Hyperopia, Presbyopia, Astigmatism, and Cataract (Brief account only).	3
	4.5	Physiology of hearing, Hearing impairments: e.g. Types of deafness, Labyrinthine disease, Tinnitus, and motion sickness (Brief account only).	1
	4.6	Physiology of olfaction and gustation. Mention receptors for touch, thermoreceptors and pain receptors (Brief account only).	2
V	**Endocrinology and Reproductive Physiology**		**9**
	5.1	Physiological functions of pituitary, Hypothalamic, Adrenocortical and pancreatic hormones.	2
	5.2	Hormonal disorders: e.g. Cretinism, Exophthalmic goitre, Graves' disease, Myxoedema, Addison's Disease, Cushing's Syndrome, Diabetes mellitus, Diabetes insipidus, Dwarfism, Gigantism and Acromegaly (Brief account only).	2
	5.3	Mode of action of hormone: Second messenger, Cell membrane receptors, and nuclear receptors.	2
	5.4	Reproductive cycles, physiology of puberty, Adolescence, Pregnancy, Parturition, and lactation.	2
	5.5	Birth control methods.	1

References

1. Barrett, Kim, Susan Barman, Jason Yuan, and Heddwen Brooks. (2019). Ganong's Review of Medical Physiology, 26th ed., McGraw Hill.
2. Hall, John E., and Michael E. Hall. (2020). Guyton and Hall Textbook of Medical Physiology, 14th ed., Elsevier.
3. Khurana, Indu. (2022). Medical Physiology for Undergraduate Students, Third Edition, Elsevier.
4. Prosser, C.L. (1978). Comparative Animal Physiology, W.B. Saunders Co.
5. Randall, David, and Kathleen French. (2001). Eckert Animal Physiology, Fifth ed., W.H. Freeman & Co Ltd.
6. Schmidt-Nielsen. (2002). Animal Physiology: Adaptation and Environment, Fifth ed., Cambridge University Press.
7. Sembulingam, K., and Prema Sembulingam. (2019). Essentials of Medical Physiology, Eighth ed., Jaypee Brothers Medical Publishers.

Suggested Reading:

1. Kenneth S Saladin. (2020). Anatomy and Physiology: The Unity of Form and Function, McGraw Hill; 8th edition.

2. Pat Willmer and Graham Stone. (2000). Environmental Physiology of Animals, Wiley–Blackwell.

Web Resources:

1. Physiology Web (https://www.physiologyweb.com/search/search_result_882.html)
2. *Human Physiology* Wikibooks (https://en.wikibooks.org/wiki/Human_Physiology)
3. Armando Hasudungan videos (https://www.youtube.com/@armandohasudungan)
4. https://www.health.harvard.edu/heart-health/want-to-check-your-heart-rate-heres-how
5. https://www.britannica.com/video/143182/organ-hearing-sound-perception
6. https://epgp.inflibnet.ac.in

Practicum (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

Sl. No.	Contents (Any two major, Any two minor and spotters)
1	Enumeration of human red blood cells and white blood cells using a haemocytometer (Demonstration & Spotter).
2	Preparation and staining of human blood smear and identification of WBC (Major practical).
3	Estimation of haemoglobin using Sahli's haemoglobinometer (Major Practical & Spotter).
4	Preparation of haemin crystals (Minor practical).
5	Recording of human blood pressure using a Manual/Electronic sphygmomanometer (Minor Practical & Spotter).
6	Counting and recording of human heartbeat (Minor practical).
7	Determine the tonicity of the solution using human RBC (Major practical).
8	Determination of clotting time using a capillary tube (Minor practical).
9	Demonstration of insect respiration using a respirometer (Demonstration & Spotter).
10	Measurement of the rate of respiration in human beings using a volumetric respirometer (Minor practical).
11	Measurement of Oxygen Saturation (SpO2) using an electronic pulse oximeter (Minor Practical & Spotter).
12	Demonstration of pregnancy test kit (Demonstration & Spotter).
13	Poster exhibition on vitamins.
14	Survey on BMR and BMI.
15	Awareness programmes on obesity and overweight.

References

1. Khurana, Indu. (2022). Medical Physiology for Undergraduate Students, Third Edition, Elsevier.
2. Sembulingam, K., and Prema Sembulingam. (2019). Essentials of Medical Physiology, Eighth ed., Jaypee Brothers Medical Publishers.

Web Resources:

1. Physiology Web (https://www.physiologyweb.com/search/search_result_882.html)
2. *Human Physiology* Wikibooks (https://en.wikibooks.org/wiki/Human_Physiology)
3. Armando Hasudungan videos (https://www.youtube.com/@armandohasudungan)
4. https://www.health.harvard.edu/heart-health/want-to-check-your-heart-rate-heres-how
5. https://www.britannica.com/video/143182/organ-hearing-sound-perception

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the importance of a balanced diet, identify various nutritional disorders, such as protein-energy malnutrition and vitamin deficiencies, and analyse the transport of respiratory gases in the blood, dissociation curves, and respiratory adaptations in different environments.	U, R, Ap, C	2, 4
CO-2	Explore blood composition, cardiovascular function, cardiac muscle features, and cardiovascular abnormalities.	R, U, An, C	2, 4
CO-3	Study the mechanisms of urine formation, osmoregulation, muscle ultrastructure, nerve impulse propagation, synaptic transmission, special senses, endocrine functions, and reproductive physiology.	U, Ap, An, C	2, 4
CO-4	Gain knowledge about hormonal disorders, reproductive cycles, and birth control methods in animals.	E, U, C	2, 4
CO-5	Develop essential skills in performing laboratory experiments in Physiology.	U, Ap	5, 6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Animal Physiology
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand the importance of a balanced diet, identify various nutritional disorders, such as protein-energy malnutrition and vitamin deficiencies, and analyse the transport of respiratory gases in the blood, dissociation curves, and respiratory adaptations in different environments.	PO1, 3, 5, 6, 7/ PSO 2, 4	U, R, Ap, C	F, C	L	P
CO-2	Explore blood composition, cardiovascular function, cardiac muscle features, and cardiovascular abnormalities.	PO1, 3, 5, 6, 7/PSO-2, 4	R, U, An, C	F, C	L	P
CO-3	Study the mechanisms of urine formation, osmoregulation, muscle ultrastructure, nerve impulse propagation, synaptic transmission, special senses, endocrine functions, and reproductive physiology.	PO1, 3, 5, 6, 7/PSO-2, 4	U, Ap, An, C	F, C	L	P
CO-4	Gain knowledge about hormonal disorders, reproductive cycles, and birth control methods in animals.	PO1, 3, 5, 6, 7/PSO-2, 4	E, U, C	F, C	L	P
CO-5	Develop essential skills in performing laboratory experiments in	PO 5, 6, 8/PSO-5, 6	U, Ap	P	L	P

	Physiology.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 2	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 3	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 4	-	1	-	2	-	-	-	1	-	2	-	1	1	1	-
CO 5	-	1	-	-	1	2	-	-	-	-	-	1	2	-	1

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low
2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:
Assignments (Any 2)

1. The impact of gut bacteria on digestion, immunity, and overall health.
2. The Glycemic Index and blood sugar control.
3. The role of artificial intelligence in cardiovascular diagnosis.
4. Mechanisms behind muscle memory and its application to rehabilitation and fitness.
5. The physiology of sleep.
6. Pain management

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of a field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	-	-	✓
CO 2	✓	-	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	-	✓	✓

University of Kerala

Discipline	**Zoology**				
Course Code	**UK5DSCZOO303**				
Course Title	**Microbiology and Immunology**				
Type of Course	**DSC**				
Semester	V				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	Microbiology and Immunology is a comprehensive course that delves into the intricate realm of microorganisms and the body's defence mechanisms against pathogens. In Microbiology, students explore historical aspects, virus and bacteria classification, microalgae, fungi characteristics, diseases, economic importance, microbial interactions, and the human microbiome. Through hands-on experiences, students gain practical insights into microbiological concepts. In Immunology, students study the immune system overview, immune responses, viral and bacterial diseases in humans, zoonotic diseases, and immunological techniques for infectious disease diagnosis. Overall, the course equips students with a profound understanding of the microbial world, host-pathogen interactions, and immune responses, preparing them for careers in research, healthcare, and biotechnology.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**History of the Development of Microbiology**	**3**
	1	Contributions of Anton Van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Paul Ehrlich and Edward Jenner for the development of Microbiology as a discipline.	1
	2	Three Domain Classification by Carl Woese: Eucarya, Eubacteria and Archeae. Mention extremophiles.	1
	3	Difference between prokaryotic and eukaryotic microorganisms.	1
II		**Microbial Diversity and Applications**	**15**

	1	Classification of viruses: Baltimore system (Brief account only). Bacteriophages: Structure and reproduction (Lytic and Lysogenic cycles). Mention viroids, prions and virusoids.	3
	2	Classification of bacteria: Bergey's Manual of Systematic Bacteriology (Brief account only). Ultrastructure of a typical bacterium. Differentiate gram-positive and gram-negative bacteria according to cell wall. Classification of bacteria based on nutrition (Autotrophs and Heterotrophs. Photosynthetic and Chemosynthetic bacteria. Saprophytes and Parasites). Culture media: Types, Bacterial growth curve. Application of bacteria in medicine, industry, agriculture and environment.	5
	3	Microalgae (mention Diatoms and Dinoflagellates) - Brief account. Harmful Algal Blooms: Mention red tide and ciguatera toxicity.	1
	4	General characteristics of fungi. Fungal diseases (Mention Aspergillosis and Candidiasis). Economic importance of fungi.	2
	5	Microbial Interactions: Beneficial interactions and harmful interactions. Microbial associations: Brief accounts on Symbiosis, Mutualism, Commensalism, and Parasitism with examples.	2
	6	Normal human microbiome: Examples and its importance in well-being. Mention prebiotics (Yogurt, Kefir, Sauerkraut, Kimchi and Kombucha) and probiotics (*Bifidobacterium bifidum* and *Lactobacillus acidophilus, L. rhamnosus*). Types of microbial toxins: Cholera toxin, Botulinum neurotoxin	2
III	**Overview of Immune System**		**10**
	1	Types of immunity: Innate and Acquired immunity, Active immunity and Passive immunity, Cell-mediated immunity and Humoral immunity.	2
	2	Cells involved in Immunity (B cell and T cells): Types and functions.	2
	3	Interferons and MHCs: Organisation of MHC locus in mice and humans.	1
	4	Lymphoid Organs: Primary and Secondary.	1
	5	Immunoglobulins: Structure, Types and functions.	1
	6	Complement system: Classical, Alternate and Lectin pathways.	1
	7	Active and Passive Immunisation: Types of vaccines (Inactivated vaccines, Attenuated vaccines, DNA vaccines, mRNA vaccines, and Conjugate vaccines).	2
IV	**Immune responses**		**8**
	1	Types of Hypersensitivity: Gell and Coombs classification.	2
	2	Autoimmunity: Rheumatoid arthritis and Lupus erythematosus (Brief account).	2

	3	Immunodeficiency diseases: Types of immunodeficiency diseases (DiGeorge syndrome, Selective IgA deficiency and AIDS).	2
	4	Transplantation Immunity: Types of grafts, Immunological basis of transplantation reactions, and Immunosuppression.	2
V	**Microbial Diseases & Diagnosis**		**9**
	1	Microbial diseases in man: Viral diseases (e.g. Chicken pox, Measles, Common cold, Herpes, Hepatitis, Poliomyelitis), Bacterial diseases (Diphtheria, Pneumonia, Leprosy, Ornithosis. Multi-drug resistant bacteria (MRSA, Carbapenem-resistant Enterobacterales)	3
	2	Concept of Zoonotic diseases: Bacterial zoonoses (Brief description of Anthrax, and Leptospirosis), Viral zoonoses (Brief description of Rabies, Ebola virus disease, and Nipah virus).	3
	3	Immunological techniques for infectious disease diagnosis: Widal test, ELISA, FISH and GISH.	3

References

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2. Chakraborty, P. (2013). A Textbook of Microbiology. New Central Book Agency, Kolkotta.
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4. Gandhi. Microbiology and Immunology notes and cases – Blackwell Publishing.
5. Heritage, J. *et al.* Introductory Microbiology. Cambridge University Press.
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7. Pelczar, M. J., Reid, R. D. and Chan, E. C. S.: Microbiology. TMH.
8. Kumar, D.D. and S Kumar: Modern concept of Microbiology. Vikas Pub House Pvt. Ltd. New Delhi
9. Heritage J, E.G.V Evans, R.A. Killington. Introduction to Microbiology. Cambridge University Press.
10. Tewari J.P, T.N. Lakhanpal, I Singh, R Gupta and B.P. Chanola. Advances in Microbiology. APH Publishing Corporation, New Delhi.
11. Jacquelyn G. Black. Microbiology: Principles and Explorations. Prentice Hall, New Jersey.
12. Patel A.H. Industrial Microbiology. Panama Publishing House New Delhi.
13. Krieg, N.R. & Holt, J.G. Bergey's Manual of Systematic Bacteriology. Vols 1 – 4. (1984-89).
14. Rao, A.S. Introduction to Microbiology. Prentice Hall of India.
15. Johnson, T.R. & Case, C.L. Lab (2003). Experiments in Microbiology.Addison Wesley.
16. Goldsby *et al*. (2003). Immunology. 5 ed., W.H. Freeman.
17. Joshi, K.R. Immunology. Agro Bios.
18. Kuby, J. Immunology. W. H. Freeman.
19. Lydyard, P.M. *et al.* Instant Notes in Immunology. Viva Books.

20. Playfair, J.H.L. *et al.* Medical Immunology for Students. Churchill Livingstone, UK.
21. Rajeshwar Reddy, K. (2007). Text Book of Immunology. AITBS Publishers, India.
22. Rao C.V. An Introduction to Immunology. Narosa Publishing House, New Delhi.
23. Roitt, I.M. Essential Immunology. Blackwell Scientific.
24. Talwar, G.P.A Handbook of Practical Immunology. Vikas, New Delhi.
25. Todd. Lecture notes on Immunology. Lowa State Uty. Press. Ane Books India.

Web resources:

1. Zoonotic diseases https://ncdc.mohfw.gov.in/wp-content/uploads/2024/02/Zoonotic-Diseases-of-Public-Health-Importance.pdf
2. Zoonotic disease and diagnosis https://www.cdc.gov/
3. Beneficial microbes: The pharmacy in the gut – Link : https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4878258/
4. Prebiotics- https://www.healthline.com/nutrition/8-fermented-foods
5. Carbapenem-resistant Enterobacterales https://www.cdc.gov/hai/organisms/cre/index.html
6. Immunology https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=2rAs1Puvga4LW93zMe83aA==
7. Environmental Microbiology, Fermentation Technology and Bioremediation https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=0Xvq9yUM2ILDrJ07FvlArQ==

Practicum (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

Sl. No.	Contents (Any two major, Any two minor and spotters)
	Immunology (Any three)
1	Study of primary and secondary lymphoid organs (Spotter. Photographs/Models).
2	Blood smear preparation and identification of white blood cells (monocytes, lymphocytes, neutrophils and eosinophils) . [Major]
3	Blood group determination- ABO and Rh.
4	Blood collection and study of the effect of anticoagulant.
5	Usage of a haemoglobinometer to measure haemoglobin content in the blood sample. (major)
6	Agglutination tests and immunological precipitation.
7	Demonstration of ELISA test.
8	Collection of serum from blood.

9	Isolation of lymphocytes from whole blood.
Microbiology (Any Three)	
1	Microscopic observation of stained preparations of *Lactobacillus* from curd (Major practical).
2	Study of symptoms of the diseases (Polio, Chickenpox, Herpes-shingles) with the help of photographs (Spotters, Using Photographs).
3	Microscopic tests for bacterial motility: Hanging drop method.
4	Sterilization and aseptic techniques: Preparation and sterilisation of glassware and solutions.
5	Antibiotic susceptibility tests: Use charts and pictures for identification.
6	Microbial spoilage of food. e.g. bread/milk/vegetables (Demonstration only).
7	Preparation of prebiotics. e.g. yogurt/sauerkraut/kimchi/kombucha (Demonstration only).
8	Study of symbiotic microorganisms with microbes, plants and animals using charts/ photographs/micro-slides.

References

Web sources:

1. https://www.britannica.com/science/ABO-blood-group-system
2. Microbiology Virtual Lab I: https://vlab.amrita.edu/?sub=3&brch=73
3. Microbiology Virtual Lab II: https://vlab.amrita.edu/?sub=3&brch=76
4. Immunology Virtual Lab I: https://vlab.amrita.edu/?sub=3&brch=69
5. Immunology Virtual Lab II: https://vlab.amrita.edu/?sub=3&brch=70

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Recognize how important microbiological discoveries have shaped our knowledge of microorganisms and investigate the richness of the microbiological world and their application in diverse disciplines.	R, U	2, 5
CO-2	Exploring beneficial and harmful microbial interactions: Implications for human health and ecosystems. Understand zoonotic diseases and learn immunological disease diagnosis methods.	R, U, An	5
CO-3	Understanding the immune system: Components, functions, and types of immunity.	U, Ap	5, 6
CO-4	Examine transplantation immunology, comprehend autoimmunity and immunodeficiency, and categorize hypersensitive reactions to gain an understanding of various immune responses and associated diseases.	U, An	5
CO-5	Develop essential skills in immunology and microbiology laboratory techniques.	U, Ap	5, 6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Microbiology and Immunology
Credits: 3:0:1 (Lecture:Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Recognize how important microbiological discoveries have shaped our knowledge of microorganisms and investigate the richness of the microbiological world and their application in diverse disciplines.	PO-6/ PSO-2, PSO-5	R, U	F, C	L	-
CO-2	Exploring beneficial and harmful microbial interactions: Implications for human health and ecosystems. Understand zoonotic diseases and	PO-1,2,6/ PSO-5	R, U, An	F, C	L	-

	learn immunological disease diagnosis methods.					
CO-3	Understanding the immune system: Components, functions, and types of immunity.	PO-6/ PSO-5, PSO-6	U, Ap	C, P	L	P
CO-4	Examine transplantation immunology, comprehend autoimmunity and immunodeficiency, and categorize hypersensitive reactions to gain an understanding of various immune responses and associated diseases.	PO-1, 2, 6/ PSO-5	U, An	C	L	0
CO-5	Develop essential skills in immunology and microbiology laboratory techniques.	PO-1, 2, 5, 6/ PSO-5, PSO-6	U, Ap	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	-	1	-	-	2	-	-	-	-	-	-	-	2	-	-
CO 2	-	-	-	-	3	-	-	1	2	-	-	-	2	-	-
CO 3	-	-	-	-	3	2	-	1	1	-	-	-	1	-	-
CO 4	-	-	-	-	2	-	-	1	2	-	-	1	2	-	-
CO 5	-	-	-	-	2	3	-	1	-	-	-	2	3	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Suggested Assignments (Any two)

1. The role of microorganisms in human health and disease.
2. The impact of microorganisms on food spoilage and preservation.
3. Autoimmune diseases: Causes, mechanisms, and treatment strategies.
4. Immunological mechanisms of vaccines: How vaccines work and their importance.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of reports
4. Submission of a field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	-	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	-	-	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5DSCZOO304**				
Course Title	**Agrochemicals and Agricultural Pest Management**				
Type of Course	**DSC**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course provides a comprehensive understanding of pest management principles, classification of pests, common agricultural pests of Kerala and different agrochemicals and their use. Integrated pest management is an essential component of sustainable agriculture. Part of the course emphasizes the principles and practices of IPM in agriculture. The course concludes with discussions on emerging trends in agrochemical research and development, Bt technology and Robotics in pest management and their potential impacts. Additionally, the course delves into innovative methods such as biopesticides, precision agriculture, genetic pest control, and the integration of robotics for efficient pest monitoring and management.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Pests -An Introduction**		**10**
	1.1	Definition of Insect Pest- Types - Domestic pests, Structural pests, Animal husbandry pests, public health pests; Pests out-break (Brief account).	3
	1.2	Common Agricultural pests of Kerala - **Paddy** (*Leptocorisa acuta*), **Coconut** (*Oryctes rhinoceros*), **Sugar cane** (*Chilo infuscatellus*), **Coffee** (*Xylotrechus quadripes*), **Tea** (*Helopeltis antonii*), **Ginger** (*Dichocrosis punctiferalis*), **Mango** (*Idioscopus niveosparus*), **Cashew** (*Placaederus ferrugineus*), **Rubber** (*Aspidiotus destructor*), **Banana** (*Odoiporus longicollis*) **Pulses** (*Helicoverpa armigera*), **Vegetables** (*Dacus cucrubitae, Erias fabia*) and **Stored grains** (*Tribolium castaneum*). Common name, features and mode of infection (Brief description).	7
II	**Agrochemicals for Pest management**		**12**
	2.1	Agrochemicals- Types- Conventional insecticides, Fungicides, Rodenticides, Nematicides, Molluscicides, Fumigants, Repellents and Attractants.	5

	2.2	Based on chemical nature: Organophosphates; Organochlorines Carbamates and synthetic pyrethroids; Structure, chemical name, physical and chemical properties; Degradation metabolism, Mode of action, uses and toxicity (Brief description).	5
	2.3	Application of Pesticides, appliances used; dose estimation for field applications.	2
III	**Integrated Pest Management (IPM)**		**5**
	3.1	Integrated Pest Management-Concept, Definition. Pest Control Methods - Natural, Biological, Mechanical, Physical, Cultural and legal aspects (Brief description).	5
IV	**Bio-pesticides**		**10**
	4.1	Definition and Source of Bio-pesticides. Microbial Biopesticides (*Beauveria bassiana* and *Bacillus thuringiensis*) Biochemical Biopesticides (Neem oil, Pyrethrins), Plant-Incorporated Protectants (*Bt* crops, RNAi-based crops) Azadirachtin and its role in pest control. Other biopesticides - Rotenone, Nicotine and Nicotinoids.	6
	4.2	Growth inhibitors or physiological antagonists, chemo-sterilant; pheromones and attractants; Insect growth regulators, juvenile hormones, moulting hormones; Chitin synthesis inhibitors. Moulting Inhibitors. (Brief account only).	4
V	**Innovative Methods in Pest management**		**8**
	5.1	Innovative biological control (Augmentative Biological Control, Conservation Biological Control, Microbial Biopesticides), Semiochemicals and Pheromones (Pheromone Traps and Lures, Mating Disruption) Precision Agriculture (Remote Sensing and GIS, Variable Rate Application (VRA), Sensor Technologies). Genetic Pest Control (Sterile Insect Technique, Gene Drive Technology). Integrated Pest Management (IPM) Decision Support Systems (Predictive Models, Smartphone Apps and Web-Based Platforms).	5
	5.2	Bt technology, transgenic plants -Advantages and disadvantages (Brief account only).	1
	5.3	Robotics in Pest management (Electronic Traps, Smart Pest Control System, Drones, RobHortic, UGVs, Agrobot).	2

References

1. Atwal, A. S. (2008) Agricultural pests of India and south East Asia, Kalyani Publishers, Ludhiana.
2. Dent, D. (2000) Insect pest management (2nd edition) CAB International.
3. Hill, D.S. (1983) Agricultural insect pests of the tropics and their control- Cambridge Univ. Press.
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6. Koul, O., Walia, S., & Dhaliwal, G. S. (2008). Essential oils as green pesticides: potential and constraints. Biopesticides International, 4(1), 63-84.
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8. Sathe T V (2003), Agrochemicals and Pest management, Daya publishing House, New Delhi, ISBN: Indian ISBN: 9788170353096.
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Web resources

1. https://croplife.org/
2. https://www.fao.org/pest-and-pesticide-management/en/
3. https://sitem.herts.ac.uk/aeru/iupac/
4. https://www.epa.gov/pesticides
5. https://www.icar.org/
6. https://www.kau.in/

Practicum (30 hrs)

Sl. No	Contents
1	Collection and preservation of Insect Pests (Any five)
2	Field Visit- Agricultural farm/ bio-control labs and submission of field records
3	Insect traps- Models/Pictures
4	Monitoring the mode of infestation and damage by pest (Any three)
5	Preparation of any one Bio pesticides.
6	Identification of common natural enemies of crop pests (Parasitoids, predators and Microbes).

References

1. Atwal A S, Agricultural pests of South Asia and their Management (2018) 7th Edition, Kalyani Publishers.
2. Emden H M (2013) Handbook of Agricultural Entomology, 1st Edition, Wiley-Blackwell Publishers.
3. Horne P (2008) Integrated Pest Management for Crops and Pastures, CSIRO Publishing.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain a comprehensive understanding of entomology. Understand pests, their classification, significance, and the factors influencing pest outbreaks. Students will analyze case studies and examples of pest outbreaks to understand the impact of pests on agriculture, public	U, An	PSO-1,2

	health, and the environment.		
CO-2	Differentiate between various types of agrochemicals and apply knowledge and skills acquired throughout the course to develop and implement agrochemical-based pest management plans.	R, U, Ap	PSO 5,6
CO3	Analyse the ecological and economic benefits of implementing IPM practices.	An	PSO 1,2
CO4	Evaluate the effectiveness and practical considerations of biopesticides compared to conventional chemical pesticides.	E	PSO 3
CO5	Understand and aware about the innovative methods in pest management and develop practical skills in implementing and evaluating innovative pest management solutions.	U, E	PSO 1, 5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Agrochemicals and Agricultural Pest Management

Credits: 3:0:1(Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1.	Gain a comprehensive understanding of entomology. Understand pests, their classification, significance, and the factors influencing pest outbreaks. Students will analyze case studies and examples of pest outbreaks to understand the impact of pests on agriculture, public health, and the environment.	PO 1,PO 2/ PSO-1,PSO 2	U, An	F, C	L	P
2.	Differentiate between various types of	PO 6,PO 8/ PSO	R, U, Ap	P	L	P

	agrochemicals and apply knowledge and skills acquired throughout the course to develop and implement agrochemical-based pest management plans.	5,PSO 6				
3	Analyse the ecological and economic benefits of implementing IPM practices.	PO 1, PO 2 /PSO 1, PSO 2	An	F, C	L	P
4	Evaluate the effectiveness and practical considerations of biopesticides compared to conventional chemical pesticides.	PO 3/PSO 3	E	P	L	P
5	Understand and develop awareness about the innovative methods in pest management and develop practical skills in implementing and evaluating innovative pest management solutions.	PO 1/PSO 1, PSO 5	U, E	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	3	2	-	-	-	-	2	3	-	-	-	-	-	-
CO 2			-	-	3	2					-	2	-	2
CO 3	3	3	-	-	-	-	3	3						
CO 4	-	-	3		-	-			3					
CO 5	3		-	-	3	-	2							

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment topics/Seminar discussions

1. Integrated Pest Management
2. Pest control methods
3. Bio-pesticides
4. Challenges and Opportunities in Organic Pest Management Practices
5. Role of Genetic Engineering in Developing Pest-Resistant Crops
6. Sustainable Pest Management Practices in Urban Environments
7. Common Agricultural pests of Kerala.
8. Different types of Agrochemicals
9. Various appliances used for application of Pesticides

Continuous and Comprehensive Assessment

1. Quiz / Debate
2. Assignment
3. Group Discussion
4. Seminar
5. Submission of report
6. Test

End Semester Assessment

1. Multiple Choice questions
2. Short answer questions
3. Essay questions
4. Practical Exam

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5DSEZOO301**				
Course Title	**Ecology and Disaster Management**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course summary	The course provides a basic understanding of biotic and abiotic components of ecosystems, characteristics of population, community, ecosystem development and energetics. Anthropogenic impacts on ecosystems are detailed under environmental pollution and man-made disasters. Assessment and management strategies to mitigate the impact of pollution and disasters are described. Experiments included in the practicum improve understanding of the theoretical aspects.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Introduction to Ecology**	**5**
	1.1	Concept of an ecosystem. Interrelationships between the living world and the environment.	1
	1.2	Structure of an ecosystem: Brief account on abiotic and biotic factors.	1
	1,3	Primary production and energy flow in an ecosystem.	1
	1.4	Pond as a typical ecosystem (Trophic relationships, producers, consumers and decomposers).	2
II		**Population Ecology**	**10**
	2.1	Characteristics of a population. Ecotypes. A brief account of metapopulation.	5
	2.2	Exponential and logistic growth, equation and patterns, r and K strategies	3
	2.3	Population regulation– density-dependent and independent factors.	2

III		**Community Ecology**	**7**
	3.1	Community characteristics: stratification, species diversity, species abundance, species dominance community periodicity. Brief accounts on a niche, trophic level and guild.	5
	3.2	Ecological succession: Types and different stages. Eg. Succession in an aquatic ecosystem.	2
IV		**Environmental Pollution**	**8**
	4.1	Types of pollution (Air, water, and soil). Sources of pollution, eutrophication, effects of pollution on the ecosystem, pollution indicators. Control and management (bioremediation, sewage treatment, green chemistry). Air pollution mapping software (eg. AirNow, IQAir, AirVisual).	5
	4.2	Sustainable development, ecosystem approach. Environment Impact Assessment, pollution sensors, green audit.	3
V		**Disaster management**	**15**
	5.1	Disaster: Definition. Classification of disasters- human-induced and natural. Natural Hazards (Cyclone, Tsunami, Heat Wave, Landslide, UrbanFloods, Floods and Earthquakes). Man-made hazards (Chemical, nuclear and biological).	4
	5.2	Cause and impact of disasters	2
	5.3	Disaster management: Prevention, mitigation strategies, preparedness. A brief account of Psychological first aid.	3
	5.4	Policies and agencies: National Disaster Management Plan, 2019**,** Kerala State Disaster Management Plan, 2016. Kerala State Disaster Management Authority (KSDMA) and National Disaster Management Authority (NDMA).	4
	5.5	Need of Disaster management strategies: A case study on Kerala flood 2018 and Uttarakhand Cloudburst. Role of Information Technology in Disasters	2

References:

1. Abbott Leon (2008). Natural Disaster, McGraw-Hill. ISBN-13: 978 0072 428650.
2. Agarwal, A. & Sen, S (1999). The Citizen & Fifth Report, Centre for Science and Environment. New Delhi.
3. Beck, W.S., Liem, K.F. & Simpson, G.G (1991). Life: An Introduction to Biology (3rd Ed.) Harper Collins Publishers, New York, pp 1361. ISBN: 006500009 9.
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11. Emmel, T.C. (1976). Population Biology. Harper & Row Publishers, New York. ISBN 06 041904 0 Coppola.
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13. Krebs, C.J. (2001). Ecology: The experimental analysis of distribution and abundance. V Edition. Benjamin Cummings. San Francisco.
14. Odum E.P. (2017). Fundamentals of ecology. Indian edition. Brooks/Cole
15. Rajalekshmi, V. (2004). Environmental and sustainable development.APH Publishing Corporation, New Delhi. ISBN 81 7648 552 7.
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18. Sharma, H.S. (2000). Ranthambore Sanctuary - Dilemma of Eco-development, Concept Publishing Company
19. Shrivastava, A.K (2023). Textbook of Disaster Management. Scientific Publishers, India.

Web Resource:

- Disaster Management www.ifrc.org/en/what-we-do/disaster-management/

Practicum (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

Sl. No	Contents (Any two major practicals, two minor practicals, demonstration and spotters)
1	Estimation of dissolved oxygen of water sample (Major Practical).
2	Estimation of CO_2 in water (Major Practical).
3	Measurement of pH of different water samples using pH meter, pH paper and indicator solution (Minor Practical).
4	Study of ecological adaptations (Spotter)
5	Primary productivity using dark and light bottles (Demonstration, Spotter)
6	Extraction of soil organisms – Berlese funnel (Demonstration, Spotter)
7	Construction of food web (Minor Practical)

8	Study of marine planktons / Freshwater planktons (Minor Practical)
9	Turbidity using Secchi disc in polluted and unpolluted waters (Demonstration, Spotter)
10	Estimation of hardness of water samples (Demonstration)
11	Ecological indicators – Identification & submission of a report with photographs
12	Field study and Report submission of any one ecologically important area – mangroves/rocky shore/pond/sacred groove/forest etc.
13	Field visit to sites of national importance having environmental issues related to pollution, natural disasters, ecosystem restoration etc. and report submission. (**Sl.No 12 & 13 can be clubbed together for a maximum of 4 days study tour programme**).

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6. Cunningham, W.P. & Cunningham, M.A. (2003). Principles of Environmental Science Inquiry and Applications. Tata McGraw Hill Publishing Company Ltd. New Delhi. ISBN 0 07 058112.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO1	To understand basic ecological concepts, processes, and interrelation between the living and nonliving.	U	1
CO2	To comprehend various attributes of populations and communities with the help of theoretical concepts and field examples	R, U	2
CO3	To understand the causes and effects of environmental pollution and the need for impact studies and sustainable development	U, Ap, An	7
CO4	To provide awareness on various disasters, their vulnerability, mitigation and resilience and gain	U, Ap, An	1

	knowledge on the impacts of disasters on the environment and society		
CO5	Students will be equipped with a better understanding of ecology, and its importance and be able to describe the most common methods used in environmental analysis.	R, Ap, An, E	

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Ecology and Disaster Management

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	To understand basic ecological concepts, processes, and interrelation between the living and nonliving.	PO-1/PSO-1	U	F, C	L	
2	To comprehend various attributes of populations and communities with the help of theoretical concepts and field examples	PO-2	R, U	F, C	L	
3	To understand the causes and effects of environmental pollution and the need for impact studies and sustainable development	PSO-7	U, Ap, An	C	L	P
4	To provide awareness on various disasters, their vulnerability, mitigation and resilience and gain knowledge on the impacts of disasters on	PO-2,4,6/PSO-2	U, Ap,An	C	L	

	the environment and society					
5	Students will be equipped with a better understanding of ecology, and its importance and be able to describe the most common methods used in environmental analysis.	PO-4/PSO-5,6	U, An	P		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	1	-	-	-	-	-	3	2	-	-	1	-
CO2	2	3	-	-	-	-	-	-	-	-	-	-
CO3	-	-	1	-	-	-	-	-	-	-	-	2
CO4	-	-	2	3	-	-	-	-	-	-	-	-
CO5	-	-	-	-	-	3	-	-	-	-	-	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Suggestive Assignments (Any two):

1. Solid and e-waste management
2. Biogeochemical cycles
3. Species interactions
4. Impact of climate change on ecosystems
5. Ramsar sites of Kerala

6. Application of microbes in pollution abatement

Continuous Comprehensive Assessment

- Assignments
- Seminar
- Field Report submission
- Test

End Semester Evaluation

- Multiple choice questions
- Very short answer questions
- Short answer questions
- Essay type questions
- Practical examination

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			
CO 3	✓			✓
CO 4		✓		
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5DSEZOO302**				
Course Title	**Fisheries Science III- Culture of Finfishes and Shellfishes**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 -399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2	5
Pre-requisites	Pass in Class XII				
Course Summary	The students will be introduced to topics such as development of aquaculture, procedures for construction and management of aquaculture systems, traditional aquaculture practices, culture of shell fishes and fin fishes, waste water aquaculture, seed production, induced breeding, seed production of freshwater prawns and culture of catfishes and air breathing fishes, effluent management system and role of organisations in aquaculture practices. The course also emphasizes the modern concepts in integrated farming and its techno-economic feasibility, collection, and transportation of feed, hypophysation, broodstock maintenance, and agencies promoting aquaculture. Students will learn about aquaculture practices by collection and identification of commercially important shellfish marine food fishes and visit to fish farms.				

Detailed Syllabus

Module	Unit	Content	45 hrs
		Freshwater Aquaculture	**16**
	1.1	Major species cultured, production trends and prospect in different parts of the world. Freshwater aquaculture resources - ponds, tanks, lakes, reservoirs etc. Wintering ponds, quarantine ponds and isolation ponds	4

I			
	1.2	Traits of important cultivable finfishes and shellfishes and their culture methods-Indian major carps, exotic carps, air breathing fishes, Tilapia cold water fishes, freshwater prawns, mussels	4
	1.3	Sewage-fed fish culture. Principles of organic cycling and detritus food chain. Composite fish culture of Indian and exotic carps-competition and compatibility .	3
	1.4	Integration of aquaculture with livestock, cultivation of aquatic macrophytes with aquaculture (makahana), Paddy cum fish/ shrimp culture	3
	1.5	Integrated farming systems: Design, farming practices of IFS with vegetables, fodder, paddy, cattle, pig, poultry, duck, rabbit and quail	2
II	**Coastal Aquaculture and Mariculture**		**12**
	2.1	Overview of sea farming and shore-based aquaculture in different parts of the world - Resources for shore-based aquaculture and sea farming in India.	3
	2.2	Traits of important cultivable fish and shellfish (Eg. seabass, milkfish, cobia, pearl spot, black tiger shrimp, American white shrimp, mud crab, mussel, oysters (edible and pearl oyster), lobster, seaweeds - Seed resources.	4
	2.3	Traditional aquaculture systems - pokkali, bheries, semi- intensive, intensive aquaculture systems	2
	2.4	Culture systems - ponds, rafts, racks, cages, poles and ropes.	2
	2.5	Sea ranching	1
III	**Culture practices of brackish and marine species**		**9**
	3.1	Hatchery production and culture technique of *P. monodon*	2
	3.2	Seed production and culture of finfishes – *Lates calcarifer*,*Etroplus suratensis.*	3
	3.3	Seed production and culture of edible mussel and pearl oyster. Pearl culture technique	3
	3.4	Crab fattening	1
IV	**Recent trends in Aquaculture**		**5**
	4.1	Biofloc Fish Culture	1
	4.2	Recirculatory aquaculture system (RAS) -Components of RAS, Species suitable for RAS	2
	4.3	Aquaponics & Integrated Multi Trophic Aquaculture (IMTA)	2
	Agencies promoting aquaculture		**3**

V	5.1	All India Coordinated Research Project on Aquaculture of ICAR., ADAK, Matsyafed, FFDAs and BFFDAs, FIRMA, KSCADC Ltd. (Kerala State Coastal Development Corporation).	2
	5.2	Central Institutes involved in aquaculture research and development - CIFA, NBFGR, CIBA, CMFRI, RGCA	1

References

1.Agrarwal, S.C. 2007. A Handbook of Fish Farming. Narendra Publishing House., New Delhi

2.Bardach JE. 1997. Sustainable Aquaculture. John Willey & Sons.

3. Billard, R. 1990. Carp Biology and Culture. Springer, NY.

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5. Chakravarthy, N.M. 2006. Murrels and Murrel Culture. Narendra Publ. Hse., New Delhi.

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7. Das, A.K., K.K. Vass, N.P. Shrivastava, P.K. Katiha. 2009. Cage Culture in Reservoirs in India. (A Handbook) WorldFish Center Technical Manual No. 1948. The WorldFish Center, Penang, Malaysia.

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CRC Press Inc., Florida.

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20. Jhingran, V.G. & R.S.V. Pullin 1985. A Hatchery Manual for the Common, Chinese and Indian Major Carps. Asian Development Bank, Manila and ICLARM, Manila.

Practicum (30 hrs)

Sl.No.	Contents
1	Identification of candidate species of shellfishes and finfishes
2	Identification of predatory and weed fishes in a farm and their methods of eradication
3	Determination of salinity by refractometer and titrimetry
4	Determination of Dissolved oxygen in pond water.
5	Determination of soil and water pH in a brackishwater and freshwater farm.
6	Determination of transparency in a pond using Secchi Disc.
7	Identification and working of various equipments in farm and hatchery
8	Identification of live feed organisms (any five)
9	Decapsulation and hatching of brine shrimp cyst.
10	Demonstration of induced breeding in carp and tiger shrimp.
11	Visit to any Aquaculture farm and submit the study report

References

1. Joseph, M.M. 1990. Aquaculture in Asia. Asian Fish. Soc., Mangalore.
2. Khanna, D.R., R. Rajani, G. Matta. 2011. Ecology of Fish Pond. Daya Publishing House, New Delhi.
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10. Wheaton, F.W. 1977. Aquaculture Engineering. Wiley Interscience, New York.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the principles and techniques of freshwater aquaculture systems, species suitable for aquaculture	U, R, An	4,5
CO-2	Understand practices of coastal aquaculture, traits of important cultivable fish and shellfish, methods of culture systems and development of sustainable farming protocols	U, R, An	4,5
CO-3	Acquire knowledge on breeding and culture of economically important brackish water species.	R, U, An	4,5
CO-4	To get familiarised with recent trends in aquaculture	AP, An, E	4,5
CO-5	To get an awareness on agencies promoting aquaculture	U, An	4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Fisheries Science III- Culture of Finfishes and Shellfishes

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Understand the principles and techniques of fresh wateraquaculture systems ,species suitable for aquaculture and integrated farming system.	PO2,3,7/ PSO4,5	U, R, An	C, P, M	L	P
2	Understand practices of major coastal aquaculture practices, traits of important cultivable fish and shellfish, methods of culture systems and development of sustainable farming protocols.	PO2,3,7/ PSO4,5	U, R, An	C, P, M	L	
3	Acquire knowledge in	PO2,3,7/	R, U, An	C, P, M	L	P

	important cultivable species, breeding and culture of economically important species in brackish water culture.	PSO4,5				
4	To get familiarise with recent trends in aquaculure	PO2,3,7/ PSO4,5	AP, An, E	C, P, M	L	
5	To get an awareness on agencies promoting aquaculture	PO1,2,3, 7/PSO4,5	U, An	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO2	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO3	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO4	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO5	-	-	-	3	3			3	2	3	-	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low

2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

- Quiz / Assignment/ Quiz/ Discussion / Seminar
- Midterm Exam
- Programming Assignments
- Final Exam

Suggested Assignments/ Seminar topics

1. Prepare an account on cultivable fresh water, marine and brackish water species in Kerala with photographs .
2. Constraints and advantages of biofloc fish farm.
3. Explore the hatchery techniques of marine shrimp.
4. Advantage of composite fish culture
5. Artificial Pearl production
6. Prepare a model of any culture system

Continuous comprehensive assessment

1. Assignment
2. Seminars
3. Submission of report
4. Submission of field report
5. Test

End Semester Evaluation

1. Multiple Choice Questions
2. Very short Answer Questions
3. Short answer Questions
4. Essay type Questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4	✓			✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5DSEZOO303**				
Course Title	**Entomology III - Medical and Veterinary Entomology**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course aims to provide undergraduate students in zoology with a comprehensive understanding of medical and veterinary entomology, focusing on the biology, ecology, and control of medically and veterinary important insects. The practical sessions are designed to enhance students' observational and analytical skills through hands-on activities and field visits.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Introduction to medical and veterinary entomology**		**6**
	1.1	Insects- General characteristics- Entomology-Brief history of medical-veterinary entomology.	2
	1.2	Definition of terms- carriers, vectors- mechanical and biological vector; Insect reservoirs, Host- vector relationship, Vectorial capacity, Host specificity	2
	1.3	Modes of disease transmission- vertical and horizontal transmission.	2
II	**Insects as vectors**		**9**
	2.1	Features of Orders with insects as vectors- Diptera, Siphonaptera, Siphunculata, Hemiptera	3

	2.2	Anatomical, physiological, cellular and molecular adaptations towards their role as vectors.	3
	2.3	Management strategies to control insect vectors- quarantine, cultural, mechanical, chemical, biological and behavioural.	3
III	**Diptera as vectors**		**10**
	3.1	Important insect vectors in Diptera-Mosquitoes, Sand flies, Houseflies.	3
	3.2	Mosquito borne diseases- Malaria, Dengue, chikungunya, Viral encephalitis, Filariasis. Veterinary importance of mosquitoes.	3
	3.3	Sand fly borne diseases- Leishmaniasis, Phlebotomous fever. Veterinary importance of Sand flies.	2
	3.4	House fly as important mechanical vector- Myiasis- Veterinary importance.	2
IV	**Siphonaptera, Siphunculata, Hemiptera as vectors**		**12**
	4.1	Fleas as insect vectors; Host specificity, Flea borne diseases- Plague, Typhus fever. Veterinary importance of fleas.	3
	4.2	Lice as disease vector, Study of Lice borne diseases-Typhus fever, relapsing fever, trench fever, Vagabond's disease, Phthiriasis- Veterinary importance of lice.	2
	4.3	Bugs as insect vectors- Blood sucking bugs, Chagas disease. Blood bugs as mechanical vectors- Veterinary importance of Bugs.	3
	4.4	Other major groups of insect vectors- Beetles, Horse flies, Deer flies, Tse Tse flies and Tabanid flies- Public health importance and Veterinary importance.	4
V	**Emerging trends and Challenges in Medical and Veterinary Entomology**		**8**
	5.1	Emerging vector-borne diseases and pest infestation.	2
	5.2	Climate change, urbanisation and other factors driving diseases	2
	5.3	Insect population suppression	2
	5.4	IPM approach for vector management	1
	5.5	Research trend and future directions	1

References

1. Apple J.L. and R.R. Smith (1976) Integrated Pest Management. Plenum Press New York.
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11. Wall, R. and Sheares, D. 1998. Veterinary Entomology. Chapman and Hall.
12. Walter G. 2003. Insect Pest Management and Ecological Research. Cambridge University Press, UK.

Practicum (30 hrs)

Sl.No.	Contents
1.	Study of insect vectors through permanent slides or photographs: *Aedes, Culex, Anopheles*, lice bed bug, *Phlebotomus* (sand fly), *Musca domestica* (house fly)
2.	Study of different diseases transmitted by above insect vectors.
3.	Project report on any one disease transmitted by insect vector.
4.	Study of life history stages of medically important Diptera, Siphonoptera.
5.	Sorting and identification of immature stages of *Culex, Aedes* and *Anopheles* mosquitoes
6.	Report preparation on morphological adaptations of insect vectors-mouthparts, wings, legs, antennae, body shape.
7.	Field visit to an insect vector laboratory and submission of report.

References

1. Apple, J.L. and R.R. Smith.1976. Integrated Pest Management. Plenum Press, New York.
2. Awasthi, V.B. 2002. Introduction to General and Applied Entomology (2nd edn). Scientific Publishers (India), Jodhpur.
3. Mullen, G. and Durden, L. (Eds).2002. Medical and Veterinary Entomology. Academic Press.
4. Patton, W.S. and Crag, F.N. 1973. A Textbook of Medical Entomology. International Books and Periodicals, New Delhi
5. Service, M.W.1996. Medical Entomology for Students. Chapman and Hall, UK
6. Metcalf, G.L. and W.P. Flint. 1962. Destructive and Useful Insects, their habits and control. Tata McGraw Hill Publ. Co Ltd. New York.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand and remember the importance of medical and veterinary entomology in present day scenario.	R,U	PSO-1,2
CO-2	To develop an insight in fundaments of vector biology and disease transmission by vectors.	R, U	PSO-1
CO-3	To analyze and evaluate the adaptations of insect for their role as successful vectors and the methods to control them.	An, E	PSO-1,2
CO-4	To compare the different orders of insects which contain vectors of medical and veterinary importance.	R,U,An	PSO-1,3
CO5	To critically evaluate the challenges in combating medical and veterinary pests.	An, E	PSO- 4
CO6	To develop the skill to identify common insect vectors.	R,U, Ap	PSO-6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Entomology III - Medical and Veterinary Entomology

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand and remember the importance of medical and veterinary entomology in the present day scenario.	PO-1/PSO-1,2	F	R,U		

2	To develop an insight in fundamentals of vector biology and disease transmission by vectors.	PO-1,6PSO-1	F,C	R, U	L	
3	To analyze and evaluate the adaptations of insect for their role as successful vectors and the methods to control them.	PO-2/PSO-1,2	C	An, E	L	
4	To compare the different orders of insects which contain vectors of medical and veterinary importance.	PO-1,6/PSO-1,3		R,U,An	L	
5	To critically evaluate the challenges in combating medical and veterinary pests.	PO-2/PSO- 4	F,C	An, E	L	
6	To develop the skill to identify common insect vectors.	PO-6/PSO-6	P	R,U, Ap		P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PSO5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**

CO 1	1	2	-	-	-	-	2	-	-	-	-	-
CO 2	2	3	-	-	-	1	3	-	-	-	-	-
CO 3	1	3	-	-	-	-	-	1	-	-	-	-
CO 4	3	-	2	-	-	-	2	-	-	-	-	1
CO 5	-	-	-	3	-	-	-	2	-	-	-	-
CO 6	2	-	-	-	-	-	-	-	-	-	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics

1.Significance of medical and veterinary entomology.
2. Emerging vector- borne diseases.
3. Different adaptations of insect vectors.
4. Salient features of orders containing medically important pests.
5. Integrated pest management to control insect vectors.
6. Mosquito- borne diseases.
7. New trends in medical and veterinary entomology.
8. Climate change and emergence of vector- borne diseases.

Continuous Comprehensive Assessment

1. Quiz
2. Assignment/Seminar
3. Internal exam
4. Report submission
5. Poster presentation

6. Viva Voce

End Semester assessment

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Essay questions
5. Practical examination

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓			
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		
CO 6			✓	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5DSEZOO304**				
Course Title	**Environmental Science III- Environmental Monitoring and Ecosystem Restoration**				
Type of Course	**DSE**				
Semester	V				
Academic Level	300--399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	The Environmental Monitoring and Ecosystem Restoration course provides students with a comprehensive understanding of the principles, methods, and applications of environmental monitoring and restoration practices. Through theoretical learning, practical exercises, and fieldwork, students gain the knowledge and skills to assess environmental conditions, monitor changes over time, and implement restoration strategies to enhance ecosystem health and resilience.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Environment Monitoring Techniques**	**11**
	1.1	**Introduction to Environment Monitoring:** Concept of environment monitoring, General applications.	1
	1.3	**Air Quality Monitoring:** Brief account on Air Quality Index, Particulate Matter (PM) PM10, PM 2.5, SO_2, Nitrogen Oxide(NOx), and Ozone.	2
	1.4	**Water Quality Monitoring:** Brief account of monitoring of pH, Hardness, Dissolved Oxygen, Carbon dioxide, BOD, COD and Heavy metal content.	2
	1.5	**Soil Quality Monitoring:** Brief account of monitoring of Alkalinity, salinity, organic carbon and soil health	1

	1.6	**Applications of Biodiversity Assessment Techniques:** Brief account of Field surveys, Taxonomic identification, Species inventories, Biotic indices (Shannon-Wiener Index, Simpson's Diversity Index, and the Index of Biological Integrity), Remote Sensing and GIS, Environmental DNA (eDNA) Sampling, Camera trapping, and Citizen science initiatives.	3
	1.7	**Bioindicators:** Relevance and uses to assess ecosystem health and identify trends in environmental quality—microbial indicators, Plant and fungal indicators, and Animal indicators.	2
II		**Environment Data Collection**	**8**
	2.1	**Field Sampling:** Brief methods of field Sampling of air, water, soil and biota.	2
	2.2	**Laboratory Analysis:** Chemical analysis (Chromatography, spectrometry, and titration to quantify concentrations of pollutants and other substances). Biological analysis (DNA sequencing, microbial assays, and bioassays to assess the health of ecosystems) (Brief account only).	2
	2.3	**GIS Data Processing:** Basics of Remote Sensing and Processing. Data analysis using Geographic Information Systems (GIS) software to map land cover, vegetation, and other environmental parameters (Brief account only).	2
	2.4	**Data Logging and Use of Sensors:** Concept of data loggers and sensors. Use of data loggers and sensors for recording environmental parameters such as temperature, humidity, pH, dissolved oxygen, and pollutant concentrations.	2
III		**Environment Data Analysis**	**8**
	3.1	**Statistical Analysis:** Application of statistical methods to analyse environmental data (Mention mean, median, and standard deviation, test hypotheses).	2
	3.2	**Spatial Analysis:** Application of GIS software in spatial analysis. Mention spatial analysis techniques.	2
	3.3	**Time Series Analysis:** Uses of time series analysis for identifying seasonal trends, long-term trends, and periodic fluctuations. Mention Time series analysis techniques (trend analysis, seasonal decomposition, and autoregressive modelling).	2
	3.3	**Environmental Data Interpretation and Reporting:** Uses of data interpretation. Interpretation (Data comparison against regulatory standards, historical trends, and scientific benchmarks to draw conclusions and make recommendations for environmental management). Brief account on reporting of environmental data.	2
IV		**Ecosystem Restoration**	**12**
	4.1	**Restoration Ecology:** The concept of ecosystem restoration. The UN Decade on Ecosystem Restoration. The role of sustainable development goals in Reducing Emissions from Deforestation and Forest Degradation in Developing Countries (REDD+). Uses of ecosystem restoration services. Brief	4

		accounts on Habitat restoration, Reforestation, Wetland rehabilitation, and Invasive species management.	
	4.2	**Techniques and Tools for Restoration Ecology:** Ecological site assessment and inventory, Restoration planning and design.	2
	4.3	**Techniques for Soil and Water Conservation in Restoration Ecology:** Seed collection, propagation, and planting techniques for restoration. Wildlife management in restoration ecology. Biomimicry and ecological engineering in restoration ecology.	2
	4.4	**Restoration of Aquatic Ecosystems:** Techniques and challenges.	2
	4.5	**Case Studies and Best Practices:** Eg. Karanji Lake (Mysuru, India), Asola-Bhatti Wildlife Sanctuary (India), Mumbai Mangrove Restoration (India), and Chesapeake Bay (US).	2
V	**Monitoring Restoration Outcomes, Policies & Regulations and Stakeholder Engagement**		**6**
	5.1	**Monitoring Restoration Outcomes:** Evaluation of restoration projects to assess success criteria, Measure progress, and Identify lessons learned for future efforts.	2
	5.2	**Policy and Regulations:** Overview of environmental policies. Regulations and guidelines. Governing, monitoring and restoration activities at local, national, and international levels.	2
	5.3	**Stakeholder Engagement and Communication:** Strategies for engaging stakeholders, communicating monitoring and restoration efforts, and fostering community involvement in environmental management.	2

References

1. Andre F. Clewell and James Aronson (2007). Ecological Restoration: Principles, Values, and Structure of an Emerging Profession. Island Press.
2. Clewell A.F. and Aronson J. (2013). Ecological Restoration: Principles, Values, and Structure of an Emerging Profession (2nd ed.). Island Press.
3. Erickson A.L., Ryan, C.M. and Jones T.A. (2021). The Science of Ecological Restoration: Creating Resilience in a Changing World. Island Press.
4. Frank R. Spellman (2012). Environmental Monitoring Handbook. CRC Press.
5. Hobbs R.J. and Suding K.N. (2018). New Models for Ecosystem Dynamics and Restoration. CRC Press.
6. James Aronson, Suzanne J. Milton, and James N. Blignaut (2007). Restoring Natural Capital: Science, Business, and Practice. Island Press.
7. Maria Csuros and Robert W. Crawford (2017). Environmental Monitoring and Analysis. CRC Press.
8. Ned Horning, Julie A. Robinson, and Eleanor J. Sterling (2007). Remote Sensing for Ecology and Conservation: A Handbook of Techniques. Oxford University Press.
9. Palmer M.A. (2016). Restoration: The Science of Restoring Ecosystems and the Human Spirit. Island Press.

10. Stuart K. Allison (2009). Ecosystem Restoration and Environmental Change: Renewing Damaged Ecosystems. CRC Press.
11. Temperton V.M., Hobbs R.J. Nuttle T., Halle S. and Tonev C. (2020). Novel Ecosystems: Intervening in the New Ecological World Order. John Wiley & Sons.
12. Yaffee S.L. and Wondolleck J.M. (2019). Ecosystem Management in the United States: An Assessment of Current Experience. Routledge.

Suggestive Readings:

1. Allison S.D. and Murphy S.D. (2019). Ecosystem Collapse and Restoration. Oxford University Press.
2. Andre F. Clewell and James Aronson (2013). Ecological Restoration, Second Edition: Principles, Values, and Structure of an Emerging Profession. Island Press.
3. Benedetti-Cecchi L. (2021). Marine restoration ecology. Oxford University Press.
4. Benson M.H. and Phillips A. (2016). Ecosystem Services and Conservation in Urbanizing Asia. Springer.
5. Clara Simon (2022). Environmental Monitoring. Murphy & Moore Publishing.
6. Felix Muller, Brian W. Baillie, and Stuart E. Weiner (2010). Handbook of Ecosystem Theories and Management. CRC Press.
7. Higgs E.S., Falk D.A., Guerrini A., Hall M.P. and Harris J.G. (2021). The Routledge Handbook of Ecological and Environmental Restoration. Routledge.
8. Janick Artiola, Ian L. Pepper, and Mark L. Brusseau (2004). Environmental Monitoring and Characterization. Academic Press.
9. Moreno-Mateos D. and Perring M.P. (2019). Ecological Restoration and Environmental Change: Renewing Damaged Ecosystems in a Changing World. Routledge.
10. Palmer M.A. Zedler J.B. and Falk D.A. (2021). Foundations of Restoration Ecology (2nd ed.). Island Press.204
11. Suding K.N. and Hobbs R.J. (2019). Handbook of Restoration Ecology (2nd ed.). Oxford University Press.

Web resources:

1. https://www.unep.org/explore-topics/water/what-we-do/monitoring-water-quality
2. https://www.unep.org/
3. https://www.downtoearth.org.in/
4. https://www.natureserve.org/
5. https://www.conservationgateway.org/Pages/default.aspx
6. https://www.epa.gov

Practicum: (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

Sl. No.	Contents (Any two)
1	**Water Quality Assessment:** Conduct field trips to nearby water bodies such as rivers/lakes/ponds to collect water samples. Perform tests to analyse parameters like pH, dissolved oxygen, turbidity, and nutrient levels using field kits or laboratory equipment. Interpret the results to assess water quality and identify potential sources of pollution. (Report submission).
2	**Soil Health Assessment:** Collect soil samples from different locations, including agricultural fields, forests, and urban areas. Conduct tests to analyze soil pH, organic matter content, nutrient levels, and microbial activity. Evaluate soil health indicators and discuss the implications for ecosystem functioning and land management practices. (Report submission).
3	**Biodiversity Surveys:** Organise biodiversity surveys in local ecosystems such as forests, grasslands, or wetlands. Use sampling techniques like transects or quadrats to document plant and animal species diversity. Analyse the data to assess the health of ecosystems, identify rare or endangered species, and monitor changes over time. (Report submission).
4	**Air Quality Monitoring:** Set up air quality monitoring stations in urban or industrial areas/Record already installed devices to measure pollutants such as particulate matter, nitrogen oxides, sulfur dioxide, and volatile organic compounds. Use portable monitoring devices or stationary instruments to collect data on air pollutant concentrations. Analyze the data to evaluate air quality trends and assess the potential health risks to human and ecological communities. (Report submission).
5	**Erosion Control Measures:** Design and implement erosion control measures in areas prone to soil erosion, such as hillsides, riverbanks, or construction sites. Techniques may include installing erosion control blankets, planting cover crops, building terraces, or constructing sediment traps. Monitor soil erosion rates before and after implementing erosion control measures to assess their effectiveness in preventing soil loss and protecting ecosystems. (Report submission).
6	**Wetland Restoration Projects:** Identify degraded wetland areas in need of restoration and develop restoration plans to enhance their ecological function and biodiversity. Activities may involve restoring natural hydrology, removing invasive species, and creating habitat features for wetland wildlife. Monitor water quality parameters, plant diversity, and wildlife populations to evaluate the success of wetland restoration efforts. (Report submission).

7	**Community Engagement and Outreach:** Organise community engagement activities such as workshops/field days/citizen science projects to raise awareness about environmental issues and involve local/residents in monitoring and restoration efforts. Encourage community participation in data collection, restoration activities, and decision-making processes to foster a sense of stewardship and ownership of natural resources. (Report submission).

References

1. Bartram, J. and Ballance R. (2017). Water Quality Monitoring: A Practical Guide to the Design and Implementation of Freshwater Quality Studies and Monitoring Programs. CRC Press.
2. David M. Nielsen (2005). Practical Handbook of Environmental Site Characterization and Ground-Water Monitoring. CRC Press.
3. Eaton E. and M.A.H. Franson (2005). Standard Methods for the Examination of Water & Wastewater. American Public Health Association 37.
4. Kareiva P. and Marvier M. (2020). Conservation Science: Balancing the Needs of People and Nture. Roberts & Company.
5. Maria Csuros and Robert W. Crawford (2017). Environmental Monitoring and Analysis. CRC Press.
6. Miguel F. Acevedo (2015). Real-Time Environmental Monitoring: Sensors and Systems. CRC Press.
7. Peterson G. D. Cumming G. S. and Carpenter S. R. (Eds.). (2021). Scenario Planning for Conservation and Management. Springer.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
1	Develop a comprehensive understanding of various environmental monitoring techniques used for assessing air quality, water quality, soil contamination, and biodiversity.	R, U, An	1, 2
2	Acquire proficiency in various methods and techniques used for collecting environmental data, including field observations, sampling, and instrumentation.	U, Ap, An	1, 2, 6
3	Develop proficiency in analyzing environmental data using various statistical methods, and data analysis techniques.	R, U, Ap, An	2, 6
4	Understand the principles and concepts of ecosystem restoration, including the importance of restoring degraded ecosystems for biodiversity conservation and ecosystem services provision.	R, U, Ap, An	1, 2
5	Understand the importance of monitoring restoration outcomes to assess the effectiveness of restoration	R, U, Ap, An	1, 2

	projects and to develop communication and negotiation skills.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Environmental Science III- Environmental Monitoring and Ecosystem Restoration

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/ Tutorial (T)	Practical (P)
1	Develop a comprehensive understanding of various environmental monitoring techniques used for assessing air quality, water quality, soil contamination, and biodiversity.	PO-1, 6/ PSO-1, 2	R, U, An	F, C	L	-
2	Acquire proficiency in various methods and techniques used for collecting environmental data, including field observations, sampling, and instrumentation.	PO-1, 2,6/ PSO-1, 2, 6	U, Ap, An	C, P	L	P
3	Develop proficiency in analyzing environmental data using various statistical methods, and data analysis techniques.	PO-1, 2, 3, 6, 7/ PSO-1, 2, 6	R, U, Ap, An	C, P	L	P
4	Understand the principles and concepts of ecosystem restoration, including the importance of restoring degraded ecosystems for biodiversity conservation and ecosystem services provision.	PO-1, 6/PSO-1, 2	R, U, Ap, An	C, P	L	P
5	Understand the importance of monitoring restoration outcomes to assess the effectiveness of restoration projects and to develop communication and negotiation skills.	PO-1, 2, 4, 6/ PSO-1, 2	R, U, Ap, An	C, P, M	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	2	1	-	-	-	-	-	1	-	-	-	-	2	-	-
CO 2	2	3	-	-	-	2	-	2	1	-	-	-	2	-	-
CO 3	1	3	-	-	-	2	-	1	2	1	-	-	1	2	-
CO 4	2	2	-	-	-	-	-	2	-	-	-	-	2	-	-
CO 5	2	2	-	-	-	-	-	1	1	-	2	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Suggestive Assignment topics (Any two):

1. Evaluate the role of citizen science in environmental monitoring and restoration efforts.
2. Community-based approaches to ecosystem restoration: Lessons from local initiatives.
3. The role of indigenous knowledge in environmental monitoring and ecosystem restoration.
4. Restoring degraded coral reefs: Challenges and innovations in marine ecosystem restoration.
5. Restoring wetland ecosystems: Strategies and success stories

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Submission of report
4. Submission of a field report

5. Tests
6. PowerPoint presentation
7. Poster presentation
8. Quiz/Debate/Discussion

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	✓	-	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK5SECZOO301**				
Course Title	**Vermiculture and Vermicomposting**				
Type of Course	**SEC**				
Semester	V				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Pass of Class XII				
Course Summary	The course on vermiculture provides an understanding of essential skills required for proficient vermicomposting and efficient vermiculture management. It covers the scope of vermiculture and species of worms suitable for vermiculture, including indigenous and exotic species. This course provides students with essential skills such as identifying suitable worm species, understanding earthworm morphology and life cycles, mastering vermicompost production techniques, byproducts of vermiculture, managing pests and pathogens effectively, and overcoming challenges in vermiculture management. These skills empower students to contribute to sustainable waste management, soil enrichment, and agricultural productivity enhancement through advanced vermiculture technologies.				

Detailed Syllabus

Module	Unit	Content	30 hrs
I	**Introduction to Vermiculture**		**5**
	1.1	Definition, Scope of Vermiculture	1
	1.2	Ecological distribution of earthworms: Epigeic, endogeic and anecic, Indigenous and exotic species suitable for vermicomposting (*Eudrilus eugeniae/Eisenia fetida/Perionyx excavatus/ Lampito mauritii).*	4
II	**Morphology of Earthworms**		**5**

	2.1	Morphological features-Segmentation, Clitellum, Genital aperture and Setae.	2
	2.2	Brief description of life cycle of Earthworm	1
	2.3	Identification of Vermi-composting species.	2
III	**Economic Importance of Vermiculture**		**6**
	3.1	Advantages of Vermicomposting, Vermicompost profile and applied aspects: Physical, Chemical and Biological properties of Vermicompost.	3
	3.2	Vermiwash, Vermicompost teas, Vermin, Vermi-remediation and Waste disposal.	3
IV	**Vermicompost Technology**		**10**
	4.1	Methodology of vermicomposting systems: Small scale earthworm farming for home gardens; Large scale farming (Pit, brick and heap systems, Kadapa slab method). Containers for culturing, raw materials, environmental pre-requisites.	6
	4.2	Feeding, harvesting, and storage of vermicompost.	4
V	**Management of Vermiculture**		**4**
	5.1	Natural enemies of earthworms (Predators and Pathogens).	2
	5.2	Management, Maintenance and Challenges in Vermiculture	1
	5.3	Training institutes (Kerala Agricultural University, Institute for Industrial Development) and Funding agencies (NABARD, State Horticulture Mission Kerala).	1

References

1. Chaudhuri, P.S. (2005). Vermiculture and vermicomposting.as biotechnology for conversion of organic wastes into animal protein and organic fertilizer. *Asian Jr. of Microbiol. Biotech. Env. Sc.*, 7(3):359-370.
2. Chaudhuri, P.S. (2006). Kenchor Jeevan Baichitra: Kencho Projukti. JyanBichitraPrakashani, Tripura, ISBN: 81-8266-088-2, 128pp.
3. Christy, M. V. (2008) Vermitechnology, 1st edition, MJP Publishers.
4. Dash, M. C. (2012) Charles Darwin's Plough Tool for Vermitechnology, I. K. International Publishing House Pvt Ltd. New Delhi, India.
5. Ismail, S.A. (1997). Vermicology - The Biology of Earthworms. OrientLongman,92pp.
6. Ismail S A (2005) The Earthworm book. 2 nd Edition. Other India Press. ISBN-13.978-8185569666-10: 8185569665.
7. Kale, R.D. (1998). Earthworms: Cinderella of organic farming. Prism Books Pvt. Ltd., Bangalore
8. Lekshmy, M. S., Santhi R. (2012) Vermitechnology, Sara Publications, New Delhi, India.

9. Mary Appelhof (1982) Worms eat my Garbage, First edition, Flower press, pp100. ISBN 9780942256031.
10. Sathe,T.V (2022) Vermiculture and Organic farming, Daya Publishing House, 9788170353287.

Web resources

1. https://www.in.gov/idem/health/greening-our-backyards/composting/worm-composting/
2. https://www.ijcmas.com/abstractview.php?ID=23101&vol=11-9-2022&SNo=22
3. https://kau.in/ml/node/12561
4. https://businesswales.gov.wales/farmingconnect/vermicomposting
5. https://www.sciencedirect.com/topics/earth-and-planetary-sciences/vermicomposting

Practicum (30 hrs)

Sl. No	Contents
1	Identification and handling of different species of earthworms used in vermiculture. (Any four)
2	Field trip- Visit to Vermicompost unit and submit a report.
3	Setting up of Vermicompost unit (Campus/Residence/ Public).
4	Study the effects of vermicompost and vermiwash on any two short duration crop plants.
5	Identification of the byproducts of vermiculture and write down their economic importance

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the scope of vermiculture and species of worms suitable for vermiculture, including indigenous and exotic species.	R,U	PSO-1,3
CO-2	Create an insight into the earthworm morphology and life cycles.	U	PSO-3
CO-3	Understand the essential skills in identifying suitable worm species required for vermicomposting.	U, Ap	PSO-5
CO-4	Apply the skills for proficient vermicomposting and efficient vermiculture management.	Ap	PSO-6
CO-5	Create an awareness about sustainable waste management, soil enrichment, and agricultural	U, A, E	PSO-6,7

	productivity enhancement through advanced vermiculture technologies.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Vermiculture and Vermicomposting
Credits: 2:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the scope of vermiculture and species of worms suitable for vermiculture, including indigenous and exotic species.	PO1/ PSO1,3	R, U	F, C	T	
2	Create an insight into the earthworm morphology and life cycles.	PO 3/ PSO 3	U	F	T	
3	Understand the essential skills in identifying suitable worm species required for vermicomposting.	PO 6/ PSO 5	U, Ap	P	T	P
4	Apply the skills for proficient vermicomposting and efficient vermiculture management.	PO 3, PO 6/ PSO 6	Ap	P,	T	P
5	Create an awareness about sustainable waste management, soil enrichment, and agricultural productivity enhancement through advanced vermiculture technologies	PO 1, PO 3, PO 7/ PSO 6, PSO 7	U, A, E	C, P	T	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PO1	PO2	PO 3	PO4	PO5	PO 6	PO 7	PO 8
CO 1	1	-	2-	-	-	-	-	1`	-	-	-	-	-	-	-
CO 2	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-
CO 3	-	-	-	-	1	-	-	-	-	-	-	-	1	-	-
CO 4	-	-	-	-	-	1	-	-	-	1	-	-	2	-	-
CO 5	-	-	-	-	-	1	2	1	-	2	-	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment /Seminar topics

1. Emerging trends and technologies in Vermiculture
2. Products of Economic Importance
3. Applications of Vermicompost in Non-agricultural sectors
4. Case Study and examples of successful vermicompost applications
5. Economic and environmental benefits of Integrating Vermiculture into agricultural practices.
6. Indigenous and exotic species used in vermiculture.
7. Training Institutes and funding agencies of Vermiculture.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of Report
4. Field Report

5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very short answer Questions
3. Short answer questions
4. Essay type Questions
5. Practical examination

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK6DSCZOO301**				
Course Title	**Cell and Molecular Biology**				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course offers a detailed exploration of cellular and molecular biology, covering cell structure, function, and regulation. Students learn about prokaryotic and eukaryotic cells, organelles, and cell communication pathways. Molecular biology topics include nucleic acids, DNA replication, gene expression, and regulation mechanisms. Through lectures and labs, students gain skills for careers in biology and biotechnology, preparing them for various opportunities in healthcare and pharmaceuticals.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Cell Structure and Organization**		**8**
	1.1	**Cell:** Characteristics of a prokaryotic cell and a eukaryotic cell (Brief account only). Fluid mosaic model of the plasma membrane.	1
	1.2	**Cytoskeleton:** Microtubules, Microfilaments and intermediate filaments (Brief account only).	1

	1.3	**Endomembrane Systems:** Brief account of structure and functions of endoplasmic reticulum, Golgi apparatus, Lysosome, and Vacuoles.	2
	1.4	**Ribosomes:** Basic structure and function. Mention types (Prokaryotic ribosomes, Archaeal ribosomes, Eukaryotic ribosomes). Ribosome locations (Free ribosomes and Membrane-bound ribosomes). **Mitochondria:** Structure (Outer and inner membranes), Functions. Mention mitochondrial diseases.	2
	1.6	**Nucleus:** Structure of interphase nucleus, Chromatin (Euchromatin and Heterochromatin), Nucleolus, Structure of a metaphase chromosome. Brief accounts of giant chromosomes (Polytene chromosomes, Lamp brush chromosomes).	2
II		**Cellular Processes**	**5**
	2.1	**Cellular Processes (Cell Growth and Division):** Cell cycle - Stages (G1, S, G2 and M phases), Mitosis and meiosis (Brief account only). Amitosis (Mention only). Cell cycle regulation (Brief account only).	3
	2.2	**Cellular Transport Mechanisms:** Passive and active transport, Endocytosis, Exocytosis, and Vesicle trafficking.	1
	2.3	**Cellular Energetics and Metabolism:** Brief account on cellular metabolism- Mention Glycolysis, Citric acid cycle, Oxidative phosphorylation and Photosynthesis.	1
III		**Cellular Communication and Signalling**	**12**
	3.1	**Cell Signalling:** Concept of cell communication. Brief accounts on cell signalling pathways and receptor-ligand interactions. Mention Extracellular (Glucagon), Intracellular (Cyclic AMP), and Intercellular (Calcium) messengers.	2
	3.2	**Types of Signalling Molecules:** Hormones, Neurotransmitters, Growth factors, Cytokines, and Extracellular matrix components (Brief account only). Modes of Cellular Signalling: Mention Endocrine signalling, Paracrine signalling, Autocrine signalling and Synaptic signalling.	2
	3.3	**Signal Transduction Pathways:** Signalling molecules (ligands), cell surface receptors, intracellular signalling molecules (e.g., kinases, second messengers), and target proteins (e.g., transcription factors). (Brief account only). Mention examples of common signalling pathways - MAPK (mitogen-activated protein kinase) pathway, the PI3K/Akt pathway, and the cAMP (cyclic adenosine monophosphate) pathway.	3
	3.4	**Cancer Biology:** Characteristics of cancer cells, Types of cancers (Benign and Malignant), Causes of cancer, Oncogenes and tumour	

		suppressor genes, Cell signalling in cancer, Cancer treatments, and Targeted drug delivery.	3
	3.5	**Ageing Process:** Characteristics of senescent cells, causes of ageing, Mention free radicals and SOD. Cellular changes during old age-related issues (Senile dementia, Osteoporosis, Senile cataract, Urinary incontinence, and Constipation.	2
Molecular Biology			
IV	**Nucleic Acids**		**9**
	4.2	**Nucleic Acids:** Molecular composition, Nucleic acid sequences, Types (DNA, RNA, Mention Artificial nucleic acids).	1
	4.3	**DNA:** Typical structure; Alternative forms of DNA (A DNA, B DNA, Z DNA); Brief account of biological functions. Mention histones.	2
	4.4	**RNA:** Structure of tRNA (Cloverleaf model), Types of RNA (Messenger RNA, Ribosomal RNA, Signal recognition particle RNA, Transfer RNA, Transfer-Messenger RNA). Biological functions of RNA.	2
	4.5	**Central Dogma of Molecular Biology:** Definition, Central dogma reverse (Teminism), One gene-one enzyme hypothesis, One gene-one polypeptide hypothesis.	1
	4.6	**DNA Replication:** DNA replication in Prokaryotes and Eukaryotes (Proof for Semi-conservative model, Messelson and Stahl experiment).	3
V	**Gene Expression & Gene Regulations**		**11**
	5.1	**Transcription:** Brief account of transcription in Prokaryotes and Eukaryotes. Mention reverse transcription and post-transcriptional modifications.	3
	5.2	**Genetic Code:** Concept of genetic code. Mention codons. Characteristics of genetic code (Reading frame and start and stop codons). A brief account of the Wobble hypothesis.	2
	5.3	**Translation:** Steps and basic mechanism of translation in prokaryotes and eukaryotes. Mention the clinical significance of translation.	3
	5.4	**Gene Regulation:** Operon, Inducible and repressible Operon system, lac operon, trp operon.	3

References

1. Cooper, G.M. and Hausman, R.E. (2016). The Cell: A Molecular Approach. 6th edition. ISBN: 978-0-87893-964-0.

2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII - Edition. Lippincott Williams and Wilkins, Philadelphia. ISBN: 0781734932, 9780781734936.
3. Geoffrey M. Cooper. (2000). The Cell 2nd edition. ASM Press & Sunderland, Washington, D.C. Sinauer Associates, MA. ISBN: 10:0-87893-106-6
4. Gerald Karp (2010). Cell and Molecular Biology: Concepts and Experiments. 6th edition. John Wiley & Sons. Inc. ISBN: 1118206738, 9781118206737.
5. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, and James Darnell (2016). Molecular Cell Biology. Publisher: W. H. Freeman, ISBN: 0716743663, 9780716743668.
6. Renu Gupta, Seema Makhija, and Ravi Toteja (2018). Cell Biology Practical Manual. Prestige Publishers.ISBN : 8193651219, 978-8193651216.
7. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2014). Molecular Biology of the Gene (7th ed.). Pearson. ISBN : 13: 978-0-321-76243-6, 10: 0-321-76243-6.

Suggestive Reading:

1. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., Roberts, K., and Walter, P. (2013). Essential Cell Biology (4th ed.). Garland Science.
2. Alberts, B., Johnson, A., Lewis, J., Morgan, D., Raff, M., Roberts, K., & Walter, P. (2002). Molecular Biology of the Cell (4th ed.). Garland Science.
3. Bruce Albert, Bray Dennis. Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland Publishing Inc., New York and London.
4. Geoffrey M. Cooper, and Robert E. Hausman.(2013). The Cell: A Molecular Approach. Publisher: Sinauer Associates, ISBN: 0878932194, 9780878932191.
5. Gohse K. C. and B. Manna. Practical Zoology. New Central Book Agency. ISBN: 788173819506, 9788173819506.
6. Gupta, P. K. (2009). Cell and Molecular Biology, Rastogi Publications, Meerut.ISBN: 144166906X, 9781441669063.
7. Hartwell, L., Goldberg, M. L., Fischer, J. A., and Hood, L. (2018). Genetics: From Genes to Genomes (6th ed.). McGraw-Hill Education.
8. Jayanta Sinha, Arun Kumar, Chatterjee and Piyali Chattopadhyay. Advanced Practical Zoology. Books and Applied (P)Ltd. ISBN: 978-81-87134-42-8.
9. Jocelyn E. Krebs, Stephen T. Kilpatrick, and Elliott S. Goldstein (2013). Lewins Genes XI. Jones & Bartlett Learning.
10. Lewin B. (2008). Gene XI. Jones and Bartlett.
11. Pollard, T. D., Earnshaw, W. C. and Lippincott-Schwartz, J. (2017). Cell Biology. Elsevier.
12. Rastogi. S. C. (2006). Cell and Molecular Biology. New Age International, ISBN. 8122412882, 9788122412888.

Web Resources:

1. Computer-Aided Drug Design Virtual Lab: https://vlab.amrita.edu/?sub=3&brch=277
2. https://epgp.inflibnet.ac.in

Practicum (30 hrs)

Sl. No.	Contents
	Cell Biology
1	Cell organelles: Sketch and label Nucleus, Ribosome, Endoplasmic reticulum, Mitochondria, Lysosome (Spotters).
2	Renowned cell biologists: Jan Evangelista Purkyne, Theodor Schwann, and Yoshinori Ohsumi (Use photographs, Spotters).
3	Stages of mitosis: Sketch and label different mitotic stages (Spotters).
4	Staining of buccal epithelial cells and Barr body (Minor practical).
5	Microscopic observation of stained preparations of *Lactobacillus* from curd.
6	Preparation of a temporary slide of onion root tip to study various stages of mitosis (Major practical).
7	Operation of a dissection microscope (Demonstration only).
8	Setting and focussing of a compound microscope (Demonstration only).
9	Meiosis: Stages in the testis of grasshopper (Demonstration only).
10	Isolation and mounting of polytene chromosomes from salivary gland cells of Drosophila (Demonstration only).
11	Localisation of mitochondria from grasshopper muscle using Janus green (Demonstration only).
12	Make PowerPoint presentations on different cell organelles (Group activity maximum 5 students in a group).
13	PowerPoint presentation on mitotic stages of grasshopper and their functions (Group activity maximum 5 students in a group).
14	Poster presentation on cell signalling pathway (Group activity maximum 5 students in a group).
	Molecular Biology
1	Watson & Crick model of DNA (Use Picture/Model, Spotters).
2	Cloverleaf model of tRNA (Use Photograph, Spotters).
3	DNA replication, transcription, translation (Use Pictures/Drawings, Spotters).

4	Lac operon and Trp operon (Use Pictures, Spotters).
5	Renowned molecular biologists: Rosalind Franklin, Barbara McClintock, Sydney Brenner, and Frederick Sanger - (Use Photographs, Spotter).
6	Animated video presentation on DNA replication (group activity).

References

1. Gohse K.C. and B. Manna. Practical Zoology. New Central Book Agency. ISBN: 788173819506, 9788173819506.
2. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, Lawrence Zipursky, and James Darnell (2016). Molecular Cell Biology. Publisher: W. H. Freeman, ISBN: 0716743663, 9780716743668.
3. Jayanta Sinha, Arun Kumar, Chatterjee and Piyali Chattopadhyay. Advanced Practical Zoology. Books and Applied (P)Ltd. ISBN: 978-81-87134-42-8.
4. Renu Gupta, Seema Makhija, and Ravi Toteja (2018). Cell Biology Practical Manual. Prestige Publishers. ISBN : 8193651219, 978-8193651216.

Suggestive Reading:

1. Rastogi. S.C. (2006). Cell and Molecular Biology. New Age International, ISBN. 8122412882, 9788122412888.

Online Resources:

1. Cell Biology Virtual Lab I: https://vlab.amrita.edu/?sub=3&brch=187
2. Cell Biology Virtual Lab II: https://vlab.amrita.edu/?sub=3&brch=188
3. Molecular Biology Virtual Lab I: https://vlab.amrita.edu/?sub=3&brch=77
4. Molecular Biology Virtual Lab II: https://vlab.amrita.edu/?sub=3&brch=186

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO1	Gain an understanding and analysis of the structure and function of cellular components.	U, An, Ap	PSO-1, 2, 3,4
CO2	Understand the cellular processes like reproduction, transport, energetics, and metabolism.	R, U, Ap	PSO-2,4
CO3	Understand the mechanism of cell signalling and the basics of cancer biology and ageing processes.	U, An	PSO-1, 2, 3,4
CO4	Gain an understanding of the molecular composition of nucleic acids and mechanisms underlying gene expression and gene regulation	U, Ap, An	PSO-1, 3,4
CO5	Attain basic laboratory skills in the usage of dissection and compound microscopes and identification of cells during cell division.	U, Ap, An	PSO -5,6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Cell and Molecular Biology

Credits: 3:0:1 (Lecture:Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Gain an understanding and analysis of the structure and function of cellular components.	PO 1, 4, 6/ PSO-1, 2, 3,4	R, U, Ap	U	L	P
2	Understand the cellular processes like reproduction, transport, energetics, and metabolism.	PO-1, 4, 5, 6/ PSO-2, 4	R, U	C	L	-
3	Understand the mechanism of cell signalling and the basics of cancer biology and ageing processes.	PO 1, 2, 5, 6/ PSO-1, 2, 3, 4	U, An	P, M	L	-
4	Gain an understanding of the molecular composition of nucleic acids and mechanisms underlying gene expression and gene regulation	PO 1, 5, 6 /PSO-1, 3, 4	U, Ap, An	C	L	P
5	Attain basic laboratory skills in the usage of dissection and compound microscopes and identification of cells during cell division.	PO 5, 6/ PSO -5, 6	U, Ap, An	P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO 1	1	1	1	2	-	-	-	1	-	-	1	-	2	-	-
CO 2	-	1	-	2	-	-	-	1	-	-	1	1	2	-	-
CO 3	1	1	1	1	-	-	-	1	1	-	-	1	2	-	-
CO 4	1	-	1	1	-	-	-	1	-	-	-	1	2	-	-
CO 5	-	-	-	-	2	3	-	-	-	-	-	2	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Suggestive Assignments (Any two):

1. Comparative analysis of prokaryotic and eukaryotic cell structures.
2. Investigate the role of cellular organelles in cell function and metabolism.
3. Investigate the role of molecular chaperones in protein folding and stability.
4. Analysis of cellular responses to environmental stresses and stimuli.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of Field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓	✓	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK6DSCZOO302**				
Course Title	**Genetics and Biotechnology**				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	The Genetics and Biotechnology course covers a wide range of topics, including Mendel's experiments, gene interactions, chromosome mapping, and genetic engineering. It explores applications in various fields such as industry, medicine, and agriculture. Through lectures, labs, and activities, students develop a deep understanding of genetic principles and biotechnological applications. Emphasis is placed on critical thinking and ethical decision-making skills necessary for navigating the complex field of genetic science and biotechnology.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Classical Genetics**	**6**
	1.1	Mendel's experiments: Law of inheritance, Law of segregation and Law of independent assortment.	2
	1.2	Gene concept, Different types of genes, One gene - one enzyme concept.	1
	1.3	Interaction of genes, Allelic-incomplete dominance, Lethal genes and Co-dominance, Epistasis - dominant and recessive, Lethal alleles, Polygenic inheritance (Skin colour in humans), Pleiotropism and Multiple alleles, ABO Blood group system.	3
		Cytogenetics	**12**
	2.1	Linkage (Complete and Incomplete linkage), Significance of linkage. Crossing over - Mechanism and its importance.	3

II		Chromosome mapping, Pedigree Analysis (Brief account only).	
	2.2	Sex-linked, Sex-limited, and Sex-influenced inheritance in animals.	1
	2.3	Mutation: Spontaneous and induced mutation	1
	2.4	Structural chromosomal aberrations (Duplications, Deletions, Inversions and Translocations) and Numerical chromosomal aberrations (Aneuploidy, Euploidy and Polyploidy).	2
	2.5	Chromosomal anomalies in man: Autosomal (e.g. Down syndrome, Edwards syndrome) and autosomal (e.g. Klinefelters syndrome, Turner's syndrome).	2
	2.6	Sex determining mechanism - Sex chromosomal mechanism (XX-XY, XX-XO, ZZ-ZW). Genic balance theory, Environmental factors on sex determination, Hormonal control of sex differentiation. Mention Barr bodies, Dosage compensation and Lyon hypothesis, Sex mosaicism, Gynandromorph and Intersex.	3
III		**Recombinant DNA technology**	**8**
	3.1	Genetic engineering and recombinant DNA technology (Brief description): Steps involved in rDNA technology.	1
	3.2	Essential tools in recombinant DNA technique: DNA modifying enzymes, Restriction endonucleases, Ligases, Polymerases, and Alkaline phosphatase.	2
	3.3	Vectors used for cloning and their applications: Plasmidvector, Cosmid vector, Phage vector, BACs, YACs, Expression vectors (Brief account only).	1
	3.4	Gene transfer techniques: Electroporation, Lipofection, Ultrasonication and Microinjection (Brief account only). Mention gene gun.	2
	3.5	Screening of Transformants: Antibiotic Selection and Blue/White Screening Methods. cDNA library and genomic library (Brief account only).	2
IV		**Techniques in Biotechnology**	**10**
	4.1	Polymerase Chain Reaction: Basic steps and applications of PCR. Mention RT-PCR and its diagnostic value.	2
	4.2	Hybridoma technology and monoclonal antibodies.	2
	4.3	Blotting Techniques: Southern, Northern and Western blotting. Mention DNA fingerprinting.	2
	4.4	Molecular hybridisation techniques for genome analysis: RFLP, AFLP, RAPD (Brief account only).	2
	4.5	Human Genome Project. DNA sequencing (Sanger method and Automated sequencing).	1
	4.6	Recent trends in Gene technology: Gene Targeting (Knock-ins and Knock-outs). Targeted Genome Editing (CRISPRs-Cas9) (Brief account only).	1
V		**Applications of Biotechnology**	**9**
	5.1	Industry, Environment and Medicine: Application of biotechnology in the industry (Eg. Bioprocess and Fermentation Technology), Environment (Eg, Bioremediation) and Medical sectors (Eg. Recombinant insulin production).	3
	5.2	Food and Agriculture: Application of biotechnology in food (Eg. Single-cell protein) and agriculture sectors (Eg. Genetically modified crops and transgenic animals).	3

	5.3	Advanced methods in sex determination: Usage of amelogenin gene in forensics, PCR-based Sex determination in birds (Brief account only).	3

References:

Genetics:

1. Benjamin Lewin (2004). Genes VIII. Oxford University Press, N.Y.
2. Brown, T. A. (1995). Gene cloning. Chapman and Hall, London.
3. Daniel J. Fairbanks and W. Ralph Brooks. (1999) Genetics – principles and analysis. Jones and Bartlett Publishers, Massachusetts.
4. Snustad D.P. (2019). Principles of Genetics, John Wiley, USA. 7th edition.

Biotechnology:

1. Kingsman, S.M. and A.J. Kingsman. (1988). Genetic Engineering. Blackwell Scientific Publications, London.
2. Nair A.J (2007). Introduction to Genetic Engineering & Biotechnology. Jones & Bartlett Publishers, Boston, USA.
3. Peter Sudbery (2002). Human Molecular Genetics. Prentice-Hall.
4. Singh, B. D. (2002). Biotechnology, Kalyani Publishers, New Delhi.

Suggestive Reading

Genetics:

1. Benjamin A. Pierce (2017). Genetics: A Conceptual Approach. WH Freeman; 6th ed.
2. William S. Klug, Michael R. Cummings, Charlotte A. Spencer, Michael A. Palladino, and Darrell Killian (2019). Concepts of Genetics. Pearson Education; Eleventh edition.
3. Robert J. Brooker (1999). Genetics- Analysis and principles. Addison-Wesley, Menlo Park, California.
4. Shukla R.S and P.S. Chandel (2007). Cytogenetics, Evolution and Biostatistics. S. Chand & Company Limited.
5. Vijayakumaran Nair, K. & Jayaprakash, M. Cell Biology, Genetics, Molecular Biology. Academica, TVM.
6. Verma, P. S. and Agarwal V.K. (2004). Cell Biology, Genetics, Molecular Biology: Evolution and Ecology. India: S. Chand Limited.
7. Strachan, I. and Read (1999). Human molecular genetics. John Wiley and Sons, New York.
8. Bernard R. Glick and Jack J. Pasternak (2003). Molecular biology. ASM Press.
9. George M. Malasinski and David Freifelder (1988). Essentials of Molecular Biology. Jones and Bartlett Publishers, London.

Biotechnology:

1. Joseph Sambrook and Michael R. Green (2012). Molecular Cloning: A Laboratory Manual. CSHL Press, New York. (2001).
2. Primrose S.B. (2001). Molecular Biotechnology. Panima Publishing Corporation.
3. Chatterjee, A.K. (2007). Environmental Biotechnology (2nd Ed.) Prentice Hall.
4. Nair A.J. (2004). Basics of Biotechnology. Laxmi Publications, New Delhi.
5. Kumar H.D. Modern concept of Biotechnology. Vikas Publishing House, Pvt. Ltd., New Delhi.
6. Magnus Lundgren, Emmanuelle Charpentier, and Peter C. Fineran (2016.) CRISPR: Methods and Protocols.

Web resources:

1. Bird sexing PCR protocols https://bento.bio/protocol/bird-sexing/bird-sexing-pcr/

2. CRISPR/Cas9 for targeted genome editing- https://www.yourgenome.org/theme/what-is-crispr-cas9/
3. Sex determination by amplification of amelogenin gene PMID: 30127199, DOI: 10.4103/ijdr.IJDR_274_17
4. https://epgp.inflibnet.ac.in

Practicum: (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

Sl. No.	Contents
Genetics (Minimum three)	
1	Study of normal chromosome complement and karyotype of man.
2	Study of genetic syndromes and abnormal karyotypes of man.
3	Study of barr body and its significance (in stained buccal epithelial cells).
4	Construction of pedigree chart.
5	Study of phenotypic characters of male and female Drosophila.
Biotechnology (Minimum three)	
1	Preparation of biochemical reagents (Normal and molar solutions).
2	Fermentation optimization: Vary parameters such as temperature, pH, and nutrient/substrate concentration to optimise the conditions for microbial fermentation (e.g. ethanol production by yeast).
3	Bioremediation experiment: Set up a bioremediation experiment to evaluate the ability of microorganisms present in natural waters to degrade pollutants.
4	Isolation of plasmid DNA/ DNA from bacteria/plant/animal samples (video demonstration).
5	Single Cell Protein (SCP) production (e.g. Chlorella, Spirulina) (Demonstration).
6	Research/Institutional visit to observe the working of equipment in biotechnology laboratories.
7	Poster presentation on Single-cell protein production (Group activity).
8	Make a PowerPoint presentation on the application of transgenic fishes in aquaculture (Group activity).
9	Make a PowerPoint presentation on different types of Biofuels and their advantages (Group activity).
10	Essay competition on Human Genome Project.

11	Make a poster on steps in RT-PCR for COVID-19 diagnosis (Group activity).
12	Make a poster on various COVID-19 diagnosis strategies (Group activity).

References

- Demonstration of DNA extraction - https://www.youtube.com/watch?v=gMl5Q1jnIpg
- Recombinant DNA technology https://www.youtube.com/watch?v=fzB7tOwv4xk
- https://microbenotes.com/single-cell-protein/

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the relationship between genes and inheritance and study genetic mechanisms and chromosomal aberrations.	R, U	5
CO-2	Analyze chromosomal anomalies and sex determination processes.	Ap, An	4, 6
CO-3	Comprehend basic tools and techniques used in rDNA technology and their specialized screening methods.	U	5
CO-4	Understand robust techniques in biotechnology, and explore recent advancements in gene Technology.	U	5
CO-5	Analyze the application of biotechnological principles in various sectors, as well as learn the advances in sex determination methods.	U, An	5
CO-6	Develop a solid understanding of genetic principles and biotechnological techniques, demonstrated through practical activities, virtual demonstrations, group activities, and institution/research laboratory visits.	U, Ap	5, 6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Genetics and Biotechnology

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	CL	KC	Lecture (L)/ Tutorial (T)	Practicum (P)
CO-1	Understand the relationship of genes and inheritance and study Genetic Mechanisms and Chromosomal Aberrations.	PO6, 8/ PSO5	R, U	F, C	L	-
CO-2	Analyse chromosomal anomalies and sex determination processes.	PO6, 8/ PSO1 PSO5 PSO6	Ap, An	C, P	L	-

CO-3	Comprehend basic tools and techniques used in rDNA technology and their specialized screening methods.	PO6/ PSO5	U	C	L	-
CO-4	Understand robust techniques in biotechnology, and explore recent advancements in Gene Technology.	PO6, 7, 8/ PSO5	U	F, C	L	-
CO-5	Analyze the application of biotechnological principles in various sectors, as well as learn the advances in sex determination methods.	PO6, 7, 8/ PSO5	U, An	C	L	-
CO-6	Develop a solid understanding of genetic principles and biotechnological techniques, demonstrated through practical activities, virtual demonstrations, and institution visits.	PO1, 5, 6, 7, 8/ PSO5, 6	U, Ap	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	-	-	-	-	3	-	-	-	-	-	-	-	2	-	1
CO 2	2	-	-	-	2	1	-	-	-	-	-	-	2	-	1
CO 3	-	-	-	-	3	-	-	-	-	-	-	-	2	-	-
CO 4	-	-	-	-	2	-	-	-	-	-	-	-	2	1	1
CO 5	-	-	-	-	3	-	-	-	-	-	-	-	2	1	1
CO 6	-	-	-	-	1	3	-	-	1	-	-	2	3	1	1

Correlation Levels:

Level	**Correlation**
-	Nil

Level	Correlation
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Suggestive Assignments (Any two)

1. The role of Mendel's experiments in shaping modern genetics
2. Applications of genetic engineering in medicine: Current advances and prospects
3. CRISPR-Cas9: Revolutionizing genome editing
4. Gene therapy: Promises and challenges

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Industrial/Field Visit Reports
4. Submission of Activity Reports
5. Tests
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examinations

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	-	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	✓	-	-
CO 6	✓	-	-	✓

University of Kerala

Discipline	**Zoology**				
Course Code	**UK6DSCZOO303**				
Course Title	**Biochemistry**				
Type of Course	**DSC**				
Semester	Vl				
Academic Level	300 –399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This undergraduate course provides an in-depth examination of the molecular mechanisms underlying biological processes, focusing on the structure, function, and regulation of biomolecules such as proteins, carbohydrates, and lipids, Graduates will be able to integrate biochemistry concepts with zoological principles to elucidate physiological processes, evolutionary adaptations, and ecological interactions in animal systems. to equip graduates with the knowledge, skills, and attributes needed to pursue diverse career paths in biochemistry, research, healthcare, biotechnology, pharmaceuticals, academia, and beyond, while also preparing them for further study at the postgraduate level.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Introduction to Biochemistry**	**3**
		Definition, Basic concepts, scope of biochemistry, Historical milestones in biochemistry, Interdisciplinary nature of biochemistry	1
		Water, buffer systems, pH changes in living systems, Micro molecules and Macromolecules	2
II		**Structure and Function of Biomolecules**	**16**
		Carbohydrates: Structure, classification monosaccharides (trioses, tetroses, pentoses, hexoses, aldoses, ketoses), Disaccharides, polysaccharides, (homo and heteropolysaccharides) and biological importance of carbohydrates.	5

		Proteins: Structure, classification of amino acids and protein, structure levels of proteins, Primary, Secondary (α-helix, sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins., haemoglobin as atypical protein, Denaturation, Renaturation and biological functions of proteins	6
		Lipids: classification- simple lipids, (neutral fats and waxes), conjugated lipids (phospholipids, sphingolipids, glycolipids, lecithin, cephalins, cerebrosides, gangliosides), derived lipids (fatty acids, steroids, prostaglandins), biological functions of lipids	5
III	**Bioenergetics and Carbohydrate Metabolism**:		**10**
		Overview of metabolism: Anabolism and catabolism, energy-rich compounds (brief account).	2
		Carbohydrate metabolism: Carbohydrate metabolism – glycogenesis, glycogenolysis, gluconeogenesis, hexose monophosphate shunt, metabolic pathway of glucose- glycolysis, Krebs cycle, Electron transport series, chemiosmotic theory, energetics: hormonal control of carbohydrate metabolism.	8
IV		**Protein and lipid metabolism**	**10**
		Protein metabolism: Catabolism of amino acids: Transamination, Deamination, Decarboxylation, Urea cycle (ornithine cycle) and hormonal control of protein metabolism.	3
		Lipid metabolism: Lipid metabolism – hydrolysis of lipid, beta-oxidation, mention alpha and omega oxidation of fatty acids, hormonal control of lipid metabolism	7
V	**Enzyme Action and Regulation**		**6**
		Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action. Iso enzymes, Clinical uses of Isoenzymes, co-enzyme, enzyme activation and inhibition.	2
		Enzyme kinetics; Chemical nature, mechanism of enzyme action Equation of Michaelis-Menten (Brief account only), Factors affecting rate of enzyme-catalyzed reactions;Concept of Km and V max,	4

References

1. Berg, Jeremy M, et al., Biochemistry 5thed, W. H. Freeman and Company, New York, 2002.
2. David W. Martin, Jr., Peter A. Mayes, Victor W. Rodwell, Harper's review of biochemistry, Lange Medical Publications,1983.
3. Eric E Conn; Paul K Stumpf; George Bruening, Outlines of Biochemistry, John Wiley & Sons, 1987.
4. Hames, B .D.; Higgins, Instant notes Biochemistry, N .M., Viva Books Pvt. Ltd., New Delhi, 2001.
5. Lehninger, Albert L, et al., Principles of biochemistry, W H Freeman & Co., New York.2000.
6. Ochs, Raymond S., Biochemistry, Jones & Bartlett Publishers, London, 2013.

7. Rafelson, Max E, et al., Basic biochemistry, Macmillan College publishing Co., New York, 1980.
8. Singh, S P, Practical manual of biochemistry/ 5th ed., CBS Publishers & Distributors, New Delhi.2014.
9. Stryer Lubert, Biochemistry,W H Freeman & Co., New York, 1995.
10. Textbook of biochemistry, Harrow, Benjamin& Mazur, Abraham, W B Saunders Co., Philadelphia, 1962.
11. Van Holde, Kensal E, et al., Principles of biochemistry, Pearson Education, New Jersey, 2006.
12. Voet, Donald, et al., Fundamentals of biochemistry, John Wiley & Sons Inc., New York, 2002.
13. Wilson, Keith and Walker, John, 5th ed., Practical biochemistry: Principles and techniques, Cambridge University Press, 2005.
14. Zubay, Geoffrey L, et al., Principles of biochemistry, Wm C Brown Publishers, 1995

Web Resources

- https//bio.libretexts.org/Bookshelves/Biochemistry/Book:_Biochem
- https://global.oup.com/uk/orc/biosciences/biochem/
- https//Hemy.org/science/biology/biochemistryttps://www.khanacad

Practicum (30 hrs)

Sl No.	Contents
1.	Measurement of pH of different samples (acidic, basic and neutral) using pH meter pH paper.
2.	Preparation of buffers (bicarbonate/ phosphate) and measurement of pH (at least two pH values).
3.	Effect of pH/ temperature on the action of salivary amylase.
4.	Paper chromatographic separation of amino acids and determination of Rf values.
5.	Detection of aromatic amino acids (Xanthoproteic Test).
6	Determination of the isoelectric pH of the given amino acid by titration method.
7.	Detection of abnormal constituents (glucose and albumin) in urine [two tests each].
8.	Detection of excretory products – ammonia (Nessler's test), urea (Ammonia generation/ Biuret test) and uric acid (Phosphotungstic acid test).
9.	Estimation of carbohydrate by the Anthrone method (colorimetric method).
10.	Estimation of protein by Lowry's method (colorimetric method).
11.	Isolation of casein from milk (demonstration)

References

1. David Plummer. (1988). A Textbook of Practical Biochemistry. McGraw Hill Education.
2. Jayaraman, J. (1981). Laboratory Manual in Biochemistry 2nd Ed. New Age International Publishers.
3. Sattanathan, G., Padmapriya, S.S., and Balamuralikrishnan, B. (2020). Practical Manual of Biochemistry. Skyfox Publishing Group. https://doi.org/10.22573/spg.020.BK/S/028

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	1. Remember the basic knowledge about, definition scope of biochemistry. 2. Identify and describe biomolecules such as carbohydrates, lipids, proteins, and nucleic acids.	R,U	PSO-5
CO-2	1. Describe the chemical structure of carbohydrates and the functions in living organisms. 2. Explain the structural diversity of carbohydrates in different biological contexts. 3. Explain the role of carbohydrates in energy storage, cellular structure, and functions.	R, U,An,E	PSO-4, PSO-5
CO-3	1. Understand the roles of various enzymes involved in carbohydrate metabolism 2. Analyze the biochemical consequences of carbohydrate metabolism and associated disorders.	U,AnE	PSO-4, PSO-5
CO4	1. Remember the basic processes involved in the metabolism of proteins and lipids and explain Catabolism of amino acids 2. Evaluate the difference between Transamination, Deamination, Decarboxylation 3.Assess the impact of protein and lipid metabolism on overall health and disease states.	U,Ap,An.E	PSO-4, PSO-5

CO5	1.Understand the various mechanisms of enzyme regulation, including allosteric regulation, covalent modification, and enzyme inhibition. 2. Evaluate the roles of enzymes in biological processes such as metabolism, signal transduction, and gene expression.	R,U.E,	PSO-4, PSO-5
CO6	Develop essential laboratory skills in biochemistry	An	PSO-6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biochemistry
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	(L)/ (T)	Practical (P)
CO-1	1. Remember the basic knowledge about, definition scope of biochemistry. 2. Identify and describe biomolecules such as carbohydrates, lipids, proteins, and nucleic acids.	PO-6/ PSO-5	R, U	F, C	**3**	-
CO-2	1. Describe the chemical structure of carbohydrates and the functions in living organisms. 2. Explain the structural diversity of carbohydrates in different biological contexts. 3. Explain the role of carbohydrates in energy storage, cellular structure, and functions.	PO-6/ PSO-4, PSO-5	R, U, An, E	C		-
CO-3	Understand the roles of various enzymes involved in carbohydrate metabolism and analyse the biochemical consequences of carbohydrate metabolism and associated disorders.	PO-6/ PSO-4, PSO-5	U, An E	C		-
CO4	1.Remember the basic processes involved in the metabolism of proteins and lipids and explain Catabolism of amino acids 2. Evaluate the difference between Transamination, Deamination, Decarboxylation	PO-6/ PSO-4, PSO-5	U, Ap, An. E	F, C		-

	3. Assess the impact of protein and lipid metabolism on overall health and disease states.					
CO5	1. Understand the various mechanisms of enzyme regulation, including allosteric regulation, covalent modification, and enzyme inhibition. 2. Evaluate the roles of enzymes in biological processes such as metabolism, signal transduction, and gene expression.	PO-6/ PSO-4, PSO-5	R, U. E,	C		-
CO6	Develop essential laboratory skills in biochemistry	PO-1, PO-6/ PSO-6	An	P	-	30

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	-	-	-	-	2	-	-	-	-	-	-	1	-	-
CO 2	-	-	-	1	3	-	-	-	-	-	-	2	-	-
CO 3	-	-	-	1	2	-	-	-	-	-	-	1	-	-
CO 4	-	-	-	1	2	-	-	-	-	-	-	2	-	-
CO 5	-	-	-	1	1	-	-	-	-	-	-	1	-	-
CO 6	-	-	-	-	-	3	1	-	-	-	-	2	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar topics

1. Biochemical Basis of Genetic Diseases in Animals
2. Nutrigenomics: Personalized Nutrition for Animal Health
3. Biochemical Markers of Animal Health and Disease
4. Biochemical Signalling
5. Carbohydrate classification and nomenclature
6. Saponification, rancidity and acid value
7. Lipoproteins
8. Tissue protein diseases
9. Haemoglobin: Structure and functions
10. Tests for abnormal constituents – glucose, albumin
11. Cholesterol and its clinical significance
12. Hyperlipidemia, Hyperlipoproteinemia and Familial Hypercholesterolemia
13. The Common lifestyle diseases (Hypertension, High Cholesterol, Diabetics) through diet.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of Field report
5. Test
6. Quiz/Debate: Debate on Junk Food: Myth or Truth

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/Seminar/Quiz	Project/Field/Institutional Visit Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5	✓	✓		✓
CO 6	✓		✓	

University of Kerala

Discipline	**Zoology**				
Course Code	**UK6DSCZOO304**				
Course Title	**Nanobiology**				
Type of Course	**DSC**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course provides a comprehensive overview of Nanobiology, covering key topics such as the definition and significance of nanobiology, nanoscale phenomena, and the interdisciplinary nature of nanoscience. It also includes detailed discussions on the types of nanomaterials, their synthesis and characterization techniques, and their applications in biology. Additionally, the syllabus delves into biosensors and nanodevices, highlighting their principles, types, and applications in nanobiology. Nanomedicine and drug delivery systems are explored, emphasizing the advantages of nanocarriers and their applications in drug delivery.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Introduction to Nanobiology**	**8**
	1.1	Definition of nanobiology and its significance in modern biology, Properties of nanoscale dimensions and their relevance.	2
	1.2	Nanoscale phenomena: Quantum confinement, surface area to volume ratio, and their impact on material properties.	2
	1.3	Learning from nature's nanostructures like DNA, protein and viruses, interdisciplinary nature of nanoscience.	2
	1.4	Advantages and disadvantages of nanomaterials compared to bulk materials.	2
II		**Nanomaterials-Classification, Synthesis and Characterization**	**10**
	2.1	Classification of nanoparticles: - one-, two- and three-dimensional confinement, Quantum dots, carbon nanotubes, and nanocomposites.	4
	2.2	Synthesis of nanomaterials: Top-down and bottom-up approaches, chemical methods and physical methods for creating nanostructures with desired properties.	3

	2.3	Characterization techniques: Exploring various methods for analyzing and measuring nanomaterials, including X-Ray Diffraction, Scanning Electron Microscopy (SEM), Transmission electron Microscopy, and Spectroscopy (brief account).	3
III	**Biosensors and Nanodevices**		**7**
	3.1	Introduction to biosensors: Principles of biosensors, components, and signal transduction mechanisms.	2
	3.2	Types of biosensors: enzyme based, cell based, immunosensors, DNA biosensors, magnetic, thermal, Fluorescent biosensors and optical biosensors.	3
	3.3	Applications of biosensors in nanobiology: Detecting biomolecules, pathogens, and environmental contaminants.	2
IV	**Nanomedicine and Drug Delivery**		**10**
	4.1	Nanoscale drug delivery systems: Nanocarriers for targeted drug delivery, pros and cons	3
	4.2	Design and development of nanocarriers: Exploring different types of nanocarriers like polymers, liposomes, and hydrogels for drug delivery	3
	4.3	Applications of nanomedicine: Drug delivery, cancer therapy, and gene therapy using nanomaterials	4
V	**Applications and toxicity of Nanomaterial**		**10**
	5.1	Nanodiagnostics, tissue engineering, and personalized medicine, Nanostructured Scaffolds for Cell Growth and Differentiation, Tissue Regeneration, Nanomaterials for biological imaging	3
	5.2	Miniaturized devices in nanobiotechnology: Introduction to lab-on-a-chip technology and its potential applications.	2
	5.3	Examples of nanomaterials in commercial products (sunscreen, electronics, clothing, cosmetics, food packaging, solar cells, paints, self-cleaning windows)	3
	5.4	Potential benefits and risks associated with nanomedicine, Biocompatibility, toxicity and safety considerations of nanomedicine	2

References

1. Chattopadhyay, K.K. (2009). Introduction to Nanoscience and Nanotechnology. Prentice Hall India Learning Private Limited.
2. Varghese, Thomas, and Balakrishna, K.M. (2023). Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials. Atlantic Publishers and Distributors (P) Ltd.
3. Shah, M.A., and Shah, K.A. (2019). Nanotechnology: The Science of Small, 2nd ed. Wiley.
4. Poole, Charles P., Jr., and Owens, Frank J. (2020). Introduction to Nanoscience and Nanotechnology, An Indian Adaptation. Wiley.
5. Singh, Shubra, and Ramachandra Rao, M.S. (2013). Nanoscience and Nanotechnology: Fundamentals of Frontiers. Wiley.

6. Rathi, Rakesh (2010). Nanotechnology (Technology Revolution of 21st Century). S Chand & Company.
7. Kulkarni, Sulabha K. (2014). Nanotechnology: Principles and Practices, 3rd ed. Springer Nature.

Suggested Reading:

1. Sonawane, A., & Sarkar, B. (Eds.) (2023). Biological Applications of Nanoparticles. Springer Nature Singapore.
2. Khan, F.A. (Ed.) (2020). Applications of Nanomaterials in Human Health. Springer Nature Singapore.

Web Resources:

1. Nanoscience Classroom Resources (https://www.nsf.gov/news/classroom/nano.jsp)
2. Understanding Nano (https://www.understandingnano.com/resources.html)
3. NanoHub (https://nanohub.org/about/simulate)
4. Science, Technology, & Nanotechnology https://libguides.adelphi.edu/c.php?g=322528&p=2160655)

Practicum: (30 hrs)

(Wherever wet lab experiments are not possible, the principles and concepts can be demonstrated through any other material or medium, including videos/virtual labs, etc.)

Sl. No.	Contents (Any two major, Any two minor and spotters)
1	Synthesis of silver/copper/zinc nanoparticles from bulk materials using environmentally friendly methods (green synthesis) based on visible colour change (Major practical).
2	Characterization of silver/copper/zinc nanoparticles synthesised by environmentally friendly methods using Uv-Vis spectrophotometer (Major practical).
3	Rapid synthesis of gold nanoparticle using sodium borohydride as reducing agents and its characterization using Uv-Vis spectrophotometer (Major Practical).
4	Assessing the toxicity of nanoparticles (silver/copper/zinc) on aquatic organisms, such as Daphnia magna/Aquarium fishes/insect pest, by exposing them to varying concentrations of nanoparticles and observing the effects (Demonstration).
5	Assessing the antimicrobial activity of silver/copper/zinc nanoparticles (Major practical)
6	Evaluating the antioxidant properties of silver, copper, and zinc nanoparticles by using DPPH assay (Minor practical).
7	Exploring the Relationship Between Particle Size and Surface Area of Zinc Hydroxide (Minor practical).
8	Examination of casein micelle nanomaterial under microscope (Minor practical).
9	Instruments used for nanomaterial characterization (photographs as spotters)

References

1. Rajagopal, K., & Venkatachalam, D.P. (2017). A Practical Manual on Synthesis of Nanoparticles and its Applications in Biology. DigitalAge Publishers.
2. Poinern, G.E.J. (2021). A Laboratory Course in Nanoscience and Nanotechnology. Taylor and Francis.

Web Resources:

1. Inspirational chemistry: Nanotechnology. (https://edu.rsc.org/resources/nanotechnology/1933.article)
2. Teach Engineering (https://www.teachengineering.org/lessons/view/uoh_nano_lesson02)
3. Nanotechnology in schools (https://www.scienceinschool.org/article/2008/nanotechnology/)
4. Nanoscience and Nanotechnology Information Resources (https://libguides.lib.msu.edu/c.php?g=411870&p=3183814)

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Definition of nanobiology and its significance in modern biology, Nanoscale phenomena, Learning from nature's nanostructures, Advantages and disadvantages of nanomaterials	**R, U**	**PSO-5**
CO-2	Classification of nanoparticles, synthesis and Characterization techniques	**U**	**PSO-5**
CO-3	Principle of biosensors, components, and signal transduction mechanisms. Types of biosensors: Applications of biosensors in nanobiology, Nanoscale drug delivery systems, Exploring different types of nanocarriers like polymers, liposomes, and hydrogels for drug delivery	**U, Ap, An**	**PSO-4,5**
CO-4	Applications of Nanomedicine, Nanodiagnostics, tissue engineering, and personalized medicine, Miniaturized devices in nanobiotechnology. Examples of nanomaterials in commercial products, Potential benefits and risks associated with nanomedicine, Biocompatibility, toxicity and safety considerations of nanomedicine	**U, Ap, An**	**PSO-5**
CO-5	Develop essential skills in performing laboratory	**U, Ap**	**PSO-5, 6**

	experiments in Nanobiology.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Nanobiology
Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/ PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Definition of nanobiology and its significance in modern biology, Nanoscale phenomena, Learning from nature's nanostructures, Advantages and disadvantages of nanomaterials	PO-1,6, PSO-5	R, U	F, C	L	-
CO-2	Classification of nanoparticles, synthesis and Characterization techniques	PO-1,2,6, PSO-5	U	F, C	L	-
CO-3	Principle of biosensors, components, and signal transduction mechanisms. Types of biosensors: Applications of biosensors in nanobiology, Nanoscale drug delivery systems, Exploring different types of nanocarriers like polymers, liposomes, and hydrogels for drug delivery	PO-1,2,6, PSO-4,5	U, Ap, An	F, C	L	-
CO-4	Applications of nanomedicine, Nanodiagnostics, tissue engineering, and personalized medicine, Miniaturized devices in nanobiotechnology. Examples of nanomaterials in commercial products, Potential benefits and risks associated with nanomedicine, Biocompatibility, toxicity and safety considerations of nanomedicine	PO-1,2,6, PSO-5	U, Ap, An	F, C	L	-

CO-5	Develop essential skills in performing laboratory experiments in Nanobiology.	PO-1,2,3,7, PSO-5, 6	U, Ap	C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	-	-	-	-	2	-	-	1	-	-	-	-	2	-	-
CO 2	-	-	-	-	2	-	-	1	1	-	-	-	2	-	-
CO 3	-	-	-	1	2	-	-	1	1	-	-	-	2	-	-
CO 4	-	-	-	-	3	-	-	1	2	-	-	-	2	-	-
CO 5	-	-	-	-	3	2	-	1	1	1	-	-	2	2	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly/Low
2	Moderate/Medium
3	Substantial/High

Assessment Rubrics:
Assignments (Any 2)

1. Principles behind two common nanomaterial characterization techniques.
2. Diagram a simple biosensor and label its key components.
3. Application of biosensors in nanomedicine.
4. Nanocarriers used for drug delivery.
5. Potential risks associated with nanomaterials.

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of a field report
5. Test
6. Quiz/Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics:

	Internal Exam	**Assignment**	**Project Evaluation**	**End Semester Examinations**
CO 1	✓	-	-	✓
CO 2	✓	-	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	-	✓	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK6DSEZOO301**				
Course Title	**Animal Behaviour and Chronobiology**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	The course on Animal Behaviour and Chronobiology provides the students a better understanding on animal behaviour in various circumstances. In addition, the important biological cycles can also be referred. Field oriented activities of this course will help the student a better understanding of animal and its interaction with environment.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Introduction to Animal Behaviour**		**5**
	1.1	Definition; Importance of studying animal behaviour	1
	1.2	Ethology - Origin and history (Brief description); Ethologists: Karl Von Frisch, Ivan Pavlov, Konrad Lorenz, Nikolaas Tinbergen	4
II	**Animal Behaviour Patterns**		**5**
	2.1	Types of Behaviour – Stereotyped behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct vs learned behaviour, Associative learning – classical, operant conditioning.	5

		Habituation and imprinting.	
III	**Social Behaviour**		**10**
	3.1	Concept of society – pros and cons of animal society.Social organization of invertebrates (example- Honey bee).	5
	3.2	Social organization of vertebrates (example-Primates)	5
IV	**Reproductive Behaviour**		**10**
	4.1	Types of reproductive Behaviour (Brief account), Mate choice, Intra and inter sexual selection (male rivalry and female choice).	8
	4.2	Sexual conflicts during parental care	2
V	**Chronobiology**		**15**
	5.1	Introduction to Chronobiology (brief account); Biological oscillation (concept of average, amplitude, phase and period)	3
	5.2	Biological rhythm – characteristics; types – short- and long-term rhythms, circadian rhythms, tidal rhythms and lunar rhythms; Circannual. Biological clock.	5
	5.3	Concept of synchronisation and masking; Zeitgeber, photic and non-photic zeitgebers	2
	5.4	Photoperiod and regulation of seasonal reproduction of vertebrates; mention role of melatonin	2
	5.5	Relevance of Biological clock in Chrono-pharmacology; Chrono-medicine and Chronotherapy.	3

References

1. Agarwal. V. K. 2010. Animal Behaviour. S. Chand Publishing. 400p.
2. Arumugham. N and Natarajan. P. 2018. Animal Behaviour- Ethology. Saras publication. 744p.
3. Goutam Kumar Saha and Subhendu Mazumdar. 2017. Wildlife Biology – An Indian Perspective. PHI Learning Pvt. Ltd 328p.
4. John. D. Palmer. 2002. The Living Clock: The Orchestrator of Biological Rhythms. 176p.
5. Jole Shackelford. 2022. An Introduction to the History of Chronobiology. Vol. 3. University of Pittsburgh Press. 400p.
6. Peter Simmons and David Young. 2012. Nerve Cells and Animal Behaviour. Cambridge University Press. (3rd Edition). 329p
7. Russell Foster and Leon Kreitzman. 2017. Circadian Rhythms: A Very Short Introduction. 168p.
8. Shukla. J. P. 2010. Fundamentals of Animal Behaviour. Atlantic Publishers and Distributors. 588p.
9. Singh. S. K. 2020. Text Book of Wildlife Management. International Book Distributing Company. (2nd revised edition). 519p.

10. Sukla. A. 2010. Text Book of Chronobiology. Discovery Publishing House. 210p.
11. Willard. L. K and Robert. B. S. 2006. Introducing Biological Rhythms: A Primer on the Temporal Organization of Life, With Implications for Health, Society, Reproduction and the Natural Environment. Springer. 656p.

Web resources

1. https://guides.library.yale.edu/animalbehavior
2. https://www.sciencedirect.com/book/9780123725813/animal-behavior
3. https://animalbehaviour.live/
4. https://ccb.ucsd.edu/the-bioclock-studio/education-resources/basics/index.html
5. https://cerebromente.org.br/n04/mente/recritmos_i.htm
6. https://ccb.ucsd.edu/the-bioclock-studio/education-resources/index.html

Practicum (30 hrs)

Sl. No	Contents
1	Plotting ethogram of animals – photographs/diagram (Any two animal) **OR** Birds call identification and listing (mobile apps Eg: Kili and others)
2	Observation and documentation of social behaviour of insects (Honey bee/ants/termites) **OR** Courtship behaviour observation in Siamese fighting fish (*Betta splendens*)
3	Zoological Garden visit, monitoring animal behaviour (Eg: Primates) and documenting (submission of brief report with photographs).
4	Geotaxis behaviour in Earthworm/Phototaxis behaviour in Insects
5	Courtship behaviour observation of live bearer fishes and its documentation (short videos/Observation) **OR** Observation and report submission of ant's nest building

References

1. Gundevia H S and Govind Singh H (2009) A Textbook of Animal Behaviour, S Chand and Company.
2. Shukla J P (2010) Fundamentals of Animal Behaviour, Atlantic Publishers.
3. Svorc P (2019) Chronobiology: The Science of biological time structure, IntechOpen Publishers.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Illustrate the animal activity in response to environment and to extend an idea to become a nature and its natural	U	PSO-1,2

	resources conservationists		
CO-2	Imagine and improve the beneficiaries' attitude to monitor the animal responses using suitable activity	C, R, U	PSO-1,2
CO-3	Understand and identify the importance of biological rhythms in animal life	U, C	PSO-1,2
CO-4	Relate the importance of animal behaviour and biological rhythms to analyse the social behaviour responses	U, A, Ap	PSO-1,2
CO-5	Summarise the biological clock importance and interpret the measures to conserve the habitat for the sustainability of animals for achieving these for its existence	A, E, Ap	PSO-1,2

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Animal Behaviour and Chronobiology

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
1	Illustrate the animal activity in response to environment and to extend an idea to become a nature and its natural resources conservationists	PO1/ PSO-1,2	U	F, C	L	P
2	Analyse and improve the beneficiaries' attitude to monitor the animal responses using suitable activity	PO2/PO 3/ PSO-1,2	C, R, U. An	P	L	P

3	Understand and identify the importance of biological rhythms in animal life	PO 1/ PO 2/ PSO-1,2	U, C	F	L	P
4	Relate the importance of animal behaviour and biological rhythms to analyse the social behaviour responses.	PO 1/ PSO-1,2	U, A, Ap	C, F	L	P
5	Summarise the biological clock importance and interpret the measures to conserve the habitat for the sustainability of animals for achieving these for its existence	PO 1/ PO 2/ PO 3/ PSO-1,2	A, E, Ap	C, F	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	PSO2	PSO3	PSO 4	PSO 5	PSO 6	PO1	PO2	PO3	PO4	PO 5	PO6	PO7	PO8
CO 1	3	2	-	-	-	-	2	-	-	-	-	-	-	-
CO 2	2	3	-	-	-	-	-	2	3	-	-	-	-	-
CO 3	3	2	-	-	-	-	2	3	-	-	-	-	-	-
CO 4	1	2	-	-	-	-	1	2	-	-	-	-	-	-
CO 5	2	1	-	-	-	-	3	2	1	-	-	-	-	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment /Seminar topics

1. Animal behavioural types
2. Animal behaviour in relation to environmental changes
3. Animal migration
4. Biological clock
5. Biological rhythms
6. Brief account of famous Ethologists
7. Social organisation in Invertebrates and Vertebrates (Any one example each).
8. Parental care in Vertebrates
9. Reproductive behaviour in animals

Continuous Comprehensive Assessment

1. Assignments
2. Seminar
3. Submission of report
4. Submission of Field report
5. Test
6. Quiz/ Debate

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK6DSEZOO302**				
Course Title	**Fisheries Science IV- Fish Processing Technologies**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 – 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	The course Fish Processing Technology provides a comprehensive understanding of the fish processing technology. The course develops practical skills for processing fish into safe and marketable products. The course helps to understand regulations and compliance requirements for fish processing. The course explores sustainable practices in fish processing and by-product utilization.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Principles of fish preservation and processing**	**10**
	1.1	Objectives of fish processing, Handling and Sanitation, Precautions taken in Onboard handling of fish, landing centre and processing unit.	3
	1.2	Nature of microbial flora in fish, Spoilage of Fish, Rigor Mortis, causes of spoilage of fish, enzymes and their role in spoilage, pathogen in fish and fishery products.	3
	1.3	Principles of fish preservation- Grading of fish, Cleaning, lowering of temperature, raising of temperature, dehydration.	4
		Preservation techniques of fishes and shellfishes	**12**

II	2.1	Curing (Drying, Salting, Smoking, chilling, freezing marinating and canning) - principle and various methods (Brief account) Freeze drying (Mention - Accelerated freeze drying and applications), Precautions in fish drying.	6
	2.2	Use of additives to arrest quality deterioration, Permitted additives in frozen foods.	3
	2.3	Packaging of Fish and Fishery Products : Irradiation Preservation and Modified Atmospheric Packaging of Fish and Fish products (MAP). Packaging and Packaging materials in fish processing. Cold Storages and Export of Fishery Products.	3
III	**Fishery By-products**		**10**
	3.1	Fish meal, Fish liver oil and Fish body oil, Fish Protein Concentrate, Fish hydrolysates, Fish meat, Fish silage, Fish maws, Shark leather, Fish manure and guano, Fish glue, Fish gelatin, Isinglass, Fish fins, Fish roe, Fish caviar and Pearl essence. Importance of biochemical and pharmaceutical products: Insulin, Fish albumin, Peptones, Fish sutures and Ambergris.	6
	3.2	Production and uses of Chitin and Chitosan (shrimp wastes) pearl essences and Bechede-mer..	2
	3.3	Seaweed by-product: Agar-agar, Alginic acid, Alginate, Mannitol, Carrageenan.	2
IV	**Value added products**		**7**
	4.1	Status of value addition to fishery products in the Indian seafood sector. Advantages of value addition.	2
	4.2	Types of value added products from Fin fish and shellfishes: Fish paste products, and diversified (battered and breaded) products - Fish and prawn pickles, fish sauce, surimi, fish sausage, fish ham, fish cake, kamaboko, fish macaroni, fish biscuits, fish burger, fish mince, fish finger, fish cutlet, fish wafer, fish chowder, fish soup, fish stacks, fillets, fish curry, fish papad, mussel products, etc (Brief account only)	5
V	**Quality Assurance and Quality Control**		**6**
	5.1	Quality Assurance – Concepts of Hazard Analysis, Critical Control Point (HACCP) in sea food safety; Good Manufacturing Practice (GMPs), Standard Operating Procedure (SOPs). Determining the quality assurance of seafood. Role of Export Inspection Council, MPEDA in fishery products. Sanitation and Quality control: Good Hygienic practices (GHPs). Sanitary Standard Operating Procedures (SSOP).	4
	5.2	National and International standards – Bureau of Indian Standards (BIS), ISO 9000: 2000 Series of Quality Assurance System, Codex Alimentarius. Certification System of Fishery Products in India.	2

References:

1.Bremmer, H.A. 2002. Safety and Quality Issues in Fish Processing. Woodhead Publ. Ltd., England.
2. Curting, C.L. 1999. Processing and Preservation. Agro Botanical Publ., Bikaner, India.
3. Gopakumar, K. 2002. Textbook of Fish Processing Technology. Indian Council of Agricultural Research, New Delhi.
4. Hall, G.M.1992 Fish Processing Technology. Chapman & Hall India, Madras, India.
5. ICAR 2006. Handbook of Fisheries and Aquaculture. Directorate of Information and Publication of Agriculture, ICAR, New Delhi.
6. Kulikov, P.I. 1978. Preparation of Meal, Oil and Protein-Vitamin Preparations in the Fishing Industry. Amerind Publ. Co. Pvt. Ltd., New Delhi.
7. Long, A.C. 2008. Fish Processing Technology. Cybertech Publ., New Delhi.
8. Moorjani, M.N. 1984. Fish Processing in India. Publ. Infor. Div., ICAR, New Delhi.
9. Murano, P.S. 2003. Understanding Food Science and Technology. Wordsworth/Thomson Learning, Belmont, USA.
10. Ninawe, A.S. & K. Rathnakumar 2008. Fish Processing Technology and Product Development. Narendra Publ. Hse, New Delhi.
11. Novikov, V.M. 1983. Handbook of Fishery Technology. Vol. 4. Amerind Publ. Co. Pvt. Ltd., New Delhi.
12. Pearson, A.M. & T.R. Dutson 1999. HACCP in Meat, Poultry and Fish Processing. In, Advances in Meat Research Series, Vol.10. Aspen Publication, Maryland.
13. Sen, D.P. 2005. Advances in Fish Processing Technology. Allied Publ. Pvt. Ltd., New Delhi.
14. Stansby, M.E. 1963. Industrial Fishery Technology. Reinhold Publ. Co., NY.
15. Windsor, M. & S. Barlow 1981. Introduction to Fishery By-products. Fishing News Books Ltd, Surrey, England.
16. Wheaton, F. W. and Lawson, T. B., 1985. Processing Aquatic Products.

Web Resources:

- https://mpeda.gov.in/
- https://www.cift.res.in/
- https://www.nifphatt.gov.in/
- https://www.eicindia.gov.in/
- HACCP Principles & Application Guidelines | FDA
- e-Krishi Shiksha (iasri.res.in)
- https://www.fao.org/flw-in-fish-value-chains/value-chain/processing-storage/en/
- https://www.bis.gov.in/
- https://krishi.icar.gov.in/

Practicum (30 hrs)

Sl .No.	Contents
1	Preparation and submission of salted fish/ dried fish / smoked fish by different methods.

2	Visits to fish processing plant /fish landing centre & submission of study report with photographs
3.	Preparation of novel value added products
4	Evaluation of freshness of fish
5.	Visits to fish by products preparation places /industry/ firms/ research institutes etc. & Submission of study report
6.	Attend on job training programme on fish processing and preservation

References:

1. Balachandran KK. (2001). Post-harvest Technology of Fish and Fish Products. Daya Publ. House.
2.Gopakumar K. (2002). Text Book of Fish Processing Technology. ICAR.
3. Ninawe, A.S. & K. Rathnakumar (2008). Fish Processing Technology and Product Development. Narendra Publ. Hse, New Delhi.
4.Nalan Gokoglu and Pinar Yerlikaya.(2015). Seafood Chilling, Refrigeration and Freezing: Science and Technology, John Wiley and Sons (Chichester)
5. Sen D.P. (2005). Advances in Fish Processing Technology. Allied Publ.
6. Venugopal V. 2006. Seafood Processing. Taylor and Francis.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO1	Understand the objectives of fish handling, processing and principles of preservation	U, R, An	4,5
CO2	Gain knowledge in preservation techniques of shell fishes and fin fishes and modern methods of preservation.	U,R, An	4,5
CO3	Understands techniques of preparation and uses of fish byproducts for commercial gain.	AP, An, E	4,5
CO4	Gain knowledge on the principles and significance of value addition to fish and fishery products and familiarize with fish packaging materials and containers.	AP, An, E	4,5
CO5	Awareness on assessment of quality of processed fish and fish by-products by national and international standards.	U, AP, An	4,5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Fisheries Science IV- Fish Processing Technologies

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the objectives of fish handling, processing and principles of preservation	PO2,3,7/PSO 4,5	U, R, An	C, P, M	L	P
2	Gain knowledge in preservation techniques of shell fishes and fin fishes and modern methods of preservation.	PO2,3,7/PSO 4,5	U,R, An	C, P, M	L	
3	Understands techniques of preparation and uses of fish byproducts for commercial gain.	PO2,3,7/PSO 4,5	AP, An,E	C, P, M	L	P
4	Gain knowledge on the principles and significance of value addition to fish and fishery products and familiarize with fish packaging materials and containers.	PO2,3,7/PSO 4,5	AP, An, E	C, P, M	L	
5	Awareness on assessment of quality of processed fish and fish by-products by national and international standards.	PO1,2,3,7/PSO 4,5	U, AP, An	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO2	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO3	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO4	-	-	-	3	3	-	-	-	2	3	-	-	-	3	-
CO5	-	-	-	3	3			3	2	3	-	-	-	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

I. Assignment /Seminar topics

1. Post mortem changes (rigor mortis and spoilage) in fishes
2. Use of chemical preservatives in preservation
3. Preparation and uses of fish meal
4. Uses and types of seaweeds
5. Preparation and uses of Marinated and fermented fish products

Field activities

1. Visit to harbours/ landing centres to collect and submission of commercially important finfishes and shellfishes

2.Attend on job training programme on fish preservation and processing

Continuous comprehensive Assessment

1. Assignment/ Quiz/ Discussion / Seminar
2. Submission of specimen collection report
3. Submission of Field report

End semester Evaluation

1. Very short answer questions
2. Short answer questions
3. Essay type questions

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓	✓		✓
CO 4	✓			✓
CO 5	✓	✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK6DSEZOO303**				
Course Title	**Entomology IV: Forensic Entomology**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in Class XII				
Course Summary	This course provides an introduction to the fascinating field of Forensic Entomology, covering its historical development and the pivotal role insects play in forensic investigations. Key topics include: Forensically Important Insects – highlighting their significance in forensic science, Life Cycles & Reproduction of forensically important insects, Techniques for collecting and preserving forensically important insects, Role of aquatic insects in forensic investigations, Post-Mortem Interval (PMI) Estimation, Analysis & Case Studies in Forensic Entomology, Ethical & Professional Considerations and Career & Research Opportunities in Forensic Entomology.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I	**Introduction to Forensic Entomology**		**5**
	1.1	Overview of Forensic Entomology	1.5

	1.2	History and development of Forensic Entomology	1
	1.3	Importance of insects in Forensic Investigations	2.5
		Related activity: *Group discussion on use of Insects for Forensic Investigations*	
II		**Forensically Important Insects**	**20**
	2.1	Forensically important insects, their identification, hierarchical classification and use in forensic science (Blow flies; Flesh flies; House flies; Cheese skippers; Beetles; Ants; Mites and Springtails) [*Brief account only*]	5
	2.2	Life Cycles of selected Forensically Important Insects [Blow Flies, Flesh Flies, Rove Beetles]	7
	2.3	Reproductive strategies of Necrophagous Insects	2
	2.4	Role of aquatic insects in Forensic Investigations	1
	2.5	Collection and Preservation of Forensically Important Insects	3
	2.6	Seasonal and Geographical Variations in Forensically Important Insect Populations	2
		Related activities: 1. *Laboratory Rearing of forensically important Insects.* *2.Identification and description of any two forensically important insects.*	
III		**PMI Estimation and Insect Colonization Patterns**	**10**
	3.1	Post-mortem interval estimation	3
	3.2	Succession of Insect species on carrion	4
	3.3	Factors influencing insect colonization	3
		Related activity: *Make a report on PMI by analysing Insect evidence provided in class*	
IV		**Analysing Insect Evidence and Case Studies in Forensic Entomology**	**17**
	4.1	Morphological identification of Insects	4
	4.2	Molecular techniques in Forensic Entomology	4
	4.3	Data interpretation and analysis	3

	4.4	Famous Forensic Entomology case–The Ruxton Case	2
	4.5	Application of entomological evidence in criminal investigation	4
		Related activities: 1. *Debate on pros and cons of using forensic entomology in criminal investigation.* *2.Case Studies – Forensic Entomology used in India for Crime investigation*.	
V	**Ethical and Professional Issues; Career Prospects of Forensic Entomology**		**8**
	5.1	Ethics in Forensic Entomology	1
	5.2	Professional standards and codes of conduct	1
	5.3	Role of the Forensic Entomologist in the criminal justice system	2
	5.4	Scope of Forensic Entomology; Research Opportunities in Forensic Entomology	2
	5.5	LNJN National Forensic Sciences University	1
	5.6	Role of Forensic Entomologists in Legal Proceedings	1
		Related activities: 1. *Write a report and have group discussion on – Scope of Forensic Entomology* *2.Organize a one hour career guidance class on – Scope of Forensic Science and Forensic Entomology.*	

References:

1. Byrd, J.H., and J.L. Castner. (2010). Forensic Entomology: The Utility of Arthropods in Legal Investigations. CRC Press
2. Dorothy Gennard (2012). Forensic Entomology: An Introduction (2nd Ed.). Wiley-Blackwell
3. Rivers, D.B. and Dahlem, G.A. (2014). The Science of Forensic Entomology. Wiley-Blackwell, UK.
4. Amendt, J., Campobasso, C.P., Goff, M.L., and M. Grassberger. (2010) Current Concepts in Forensic Entomology. Springer.
5. Goff, M. Lee. (2000). A Fly for the Prosecution:how insect evidence helps solve crimes. Harvard University Press, London.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Identify and classify common insect species associated with forensic investigations, understanding their life cycles and ecological roles in decomposition processes	U	PSO-1,2
CO-2	Analyze the stages of insect colonization on human remains to estimate Post-Mortem Interval (PMI) and evaluate environmental factors influencing insect activity.	R, U, An	PSO-1,2
CO 3	Apply principles of entomological evidence collection, preservation, and analysis to crime scene investigations, demonstrating proficiency in forensic entomological techniques.	R, U, An, Ap	PSO-1,2
CO 4	Evaluate the significance of entomological evidence in legal contexts, including presenting findings accurately and effectively in written reports and courtroom testimony.	R, U, An, Ap, E	PSO 5, 7,8
CO 5	Critically assess current research and emerging technologies in forensic entomology, demonstrating an understanding of ethical considerations and potential applications in criminal investigations.	R, U, An, Ap, E, C	PSO-7,8

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course –Entomology IV: Forensic Entomology

Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Identify and classify common insect species associated with forensic investigations, understanding their life cycles and ecological roles in decomposition	PSO 1,2	U	F, C	L	-

	processes					
2	Analyse the stages of insect colonization on human remains to estimate postmortem interval (PMI) and evaluate environmental factors influencing insect activity.	PSO 1,2	R, U, An	F, C, P	L	-
3	Apply principles of entomological evidence collection, preservation, and analysis to crime scene investigations, demonstrating proficiency in forensic entomological techniques.	PSO 1, 2	R,U, An, Ap	F,C,P	L	-
4	Evaluate the significance of entomological evidence in legal contexts, including presenting findings accurately and effectively in written reports and courtroom testimony.	PSO 5,6,7,8	R,U, An, Ap, E	F,C, P	L	-
5	Critically assess current research and emerging technologies in forensic entomology, demonstrating an understanding of ethical considerations and potential	PSO 7,8	R,U, An, Ap, E, C	F, C, P	L	-

	applications in criminal investigations.					

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs:

	PSO 1	PSO 2	PSO 3	PSO 4	PS O5	PSO 6	PSO 7	PSO 8	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8
CO 1	2	2	-	-	-	-			3	-	-	1	-	-	-	--
CO 2	2	3	-	-	-	-				3	--	2	-	-	-	-
CO 3	2	2	-	-	-	-				3	-	1	-	-	-	2
CO 4	-	-	-		2	-	3	3	-	-	-	1	2	2	-	-
CO 5	-	-	-	-	-	-	3	3	-	-	-	2	2	2	2	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar Topics

1. Laboratory Rearing of Forensic Insects.
2. Collection of entomological evidence during death investigations.
3. Decomposition of carrion in aquatic environments.
4. Microbiomes of carrion and forensic insects.
5. Temperature tolerance of Necrophagous flies.

6. Chemical attraction and Communication in Forensically Important Insects.
7. Entomological Alteration of Blood stain Evidence.
8. Role of Forensic Entomology in Differentiating Antemortem and Postmortem Injuries.
9. Forensic Entomotoxicology: Role of Drugs and Toxins in Insect Development.
10. Insect Evidence in Forensic Archaeology.
11. Forensic Entomology – in the Indian Forensic Science.
12. Case Studies – Forensic Entomology used in India for Crime investigation.

Continuous Comprehensive Assessment (CCA)

1. Assignments
2. Seminar
3. Collection of any two forensically important insects
4. Identification and description of any two forensically important insects.
5. Test
6. Quiz
7. Debate on pros and cons of using forensic entomology in criminal investigation.

End Semester Evaluation (ESE)

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment/ Seminar	CCA	End Semester Examinations
CO 1	-	✓	✓	✓
CO 2	-	✓	✓	✓
CO 3	-	-	✓	✓
CO 4	-	-	-	✓
CO 5	-	✓	✓	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK6DSEZOO304**				
Course Title	**Environmental Science IV- Green Technologies**				
Type of Course	**DSE**				
Semester	VI				
Academic Level	300-399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	4 hours	-	-	4
Pre-requisites	Pass in Class XII				
Course Summary	Green technologies, also known as clean technologies or sustainable technologies, encompass a range of innovations and practices aimed at reducing environmental impact and promoting sustainability across various sectors of society. A course on green technologies provides students with the knowledge and skills necessary to understand, develop, and implement solutions to pressing environmental challenges.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Introduction to Green Technology**	**3**
	1.1	**Introduction to Green Technologies:** Concept of green technology. A brief account of the multidisciplinary approach.	1
	1.2	**Role of Green Technology:** Role in environmental sustainability and mitigating climate change. Brief description of the future of green technology.	2
II		**Renewable Energy**	**21**
	2.1	**Renewable Energy:** Definition. Role in addressing climate change. Mention sources of renewable energy (Renewable energy sources, including solar, wind, hydroelectric, geothermal, and biomass energy).	2
	2.2	**Solar Energy Technology:** Concept of solar energy generation, including photovoltaic (PV) systems, concentrating solar power (CSP), solar thermal collectors, and their applications in residential, commercial, and industrial settings.	3
	2.3	**Wind Energy Systems:** Wind turbine technology, wind farm design, wind resource assessment, and the integration of wind power into electricity grids. Advantages and challenges associated with wind energy.	3

	2.4	**Hydropower Generation:** Concept of hydropower generation. Conventional hydroelectric dams, run-of-river hydro, and pumped storage hydro. Role in providing reliable and renewable electricity.	3
	2.5	**Geothermal Energy:** Definition. Geothermal energy extraction methods (hydrothermal systems, enhanced geothermal systems (EGS), and geothermal heat pumps). Applications for heating, cooling, and electricity generation.	3
	2.6	**Biomass and Bioenergy:** Use of biomass resources - Wood, agricultural residues, and organic waste, bioenergy production through processes like combustion, gasification, and anaerobic digestion. Contribution to renewable energy production and waste management. **Related activity:** *Quiz competition can be adapted for mode of learning, Group activity, Maximum 5 students in a quiz team.*	3
	2.7	**Emerging Green Technologies and Policies:** Enhanced geothermal systems (EGS), Green hydrogen and Marine energy. Policies and Organisations - Brief account on the Energy policy of India, International Renewable Energy Agency (IRENA), and Sustainable Energy for All (SEforALL). **Related activity**: *PowerPoint presentations by students can be adapted for learning experience, Group activity, Maximum 5 students in a group*.	4
III		**Energy Efficiency, Energy Auditing and Sustainable Transportation**	**18**
	3.1	**Energy Efficiency:** Concept of reducing energy consumption and minimizing waste. Brief account on building design and construction, energy-efficient appliances and equipment, smart grids, and energy management systems. **Related activity**: *Poster presentation can be adapted for learning. Group activity, Maximum 5 students in a group.*	4
	3.2	**Green Building and Infrastructure:** Role in reducing energy consumption and environmental footprint. Green building standards, materials, technologies, and certification programs such as LEED (Leadership in Energy and Environmental Design). Mention building energy efficiency strategies and measures for improving energy efficiency in buildings (Passive design techniques, Energy-efficient building materials, Building envelope improvements, and Smart building technologies).	5
	3.3	**Energy Audit:** Concept of Energy Audit. Objectives of energy auditing (Systematic evaluation of energy use, Identification of energy wastage, and Recommendation of cost-effective measures to improve energy efficiency). Energy Management Systems: A brief account of energy management systems (ISO 50001). Types of Energy Audits: Walk-through audits, Preliminary audits, Detailed audits, and Investment-grade audits. Steps in energy audit - Brief accounts on Energy data collection and analysis- Energy efficiency measures: Economic analysis. Mention energy audit tools and software. **Related activity**: *PowerPoint presentations by students can be adapted for learning experience, Group activity, Maximum 5 students in a group.*	5
	3.4	**Sustainable Transportation:** Concept of sustainable transportation. Mention the contribution of transportation to global greenhouse gas emissions. Sustainable transportation solutions (Electric vehicles, Public transportation systems, Bike-sharing programs, and Alternative fuels like biofuels and hydrogen). A brief account of human health benefits of adopting sustainable transportation methods. **Related activity**: *Debate can be adapted for learning.*	4
IV		**Waste Management and Water Conservation**	**12**

	4.1	**Waste Management and Recycling:** Concept of sustainable waste management. Strategies for reducing, recycling, and managing waste (Composting, waste-to-energy technologies, and circular economy principles). Mention extended producer Responsibility (EPR) and its role in sustainable waste management. **Related activity**: *Quiz competition can be adapted for mode of learning, Group activity, Maximum 5 students in a quiz team.*	3
	4.2	**Water Conservation and Treatment:** Concept of water conservation. A brief account of sustainable treatment methods.	2
	4.3	**Technologies for Water Conservation:** Technologies for conserving water resources, improving water quality and treating wastewater. Water-efficient appliances, Rainwater harvesting and Greywater recycling **Related activity:** *Awareness lecture and a Quiz competition for students can be adapted, A Maximum of five students in a Quiz Team.*	5
	4.4	Advanced wastewater treatment methods **Related activity:** *Poster presentation can be adapted for learning. Group activity, Maximum 5 students in a group.*	2
V		**Sustainable Agriculture and Farming Practices**	**6**
	5.1	**Sustainable Agriculture:** Concept of sustainable agriculture. Mention the contribution of agriculture to environmental degradation and human health.	2
	5.3	**Sustainable Farming Practices:** Sustainable farming practices to mitigate environmental degradation. Methods of sustainable farming (Organic farming, Green aquaculture, Agroecology, Permaculture, Precision agriculture, and technologies for soil conservation and water management). **Activity:** *PowerPoint presentations by students can be adapted for the learning experience, Group activity, Maximum 5 students in a group.*	4

References

1. Aravindan S.R. (2020). Green Technologies for Sustainable Water Management, McGraw Hill Education.
2. Marrianne Fox (2016). Green technology. Syrawood Publishing House.
3. Sanjay Kumar Kar (2020). Advances in Green Energy Systems and Smart Grid: First International Conference on Intelligent Manufacturing and Internet of Things and 5th International Conference on Computing for Sustainable Energy and Environment, CRC Press.
4. Soli J. Arceivala (2017). Green Technologies. McGraw Hill Education, First Edition.

Suggestive Readings:

1. Michael Hall (2012). Green Technologies in Food Production and Processing, Routledge.
2. Nilesh J. Vasa (2021). Green Technology Applications for Enterprise and Academic Innovation, CRC Press.
3. Yingxu Wang (2017). Green Computing: Large-Scale Energy Efficiency, Publisher: Wiley.

Web resources:

- GreenBiz: https://www.greenbiz.com
- Environmental Protection Agency (EPA): https://www.epa.gov/green-technology
- United Nations Environment Programme (UNEP): https://www.unep.org/greeneconomy

- National Renewable Energy Laboratory (NREL): https://www.nrel.gov/research/green-technology.html
- Green Technology: https://www.greentechnologyinfo.com/
- Clean Energy Institute: https://www.cei.washington.edu/research/green-technologies/
- Sustainable Development Technology Canada (SDTC): https://www.sdtc.ca/en/
- Green Technology Forum: https://greentechforum.org/

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Impart a foundational understanding of sustainable technologies and their applications in addressing environmental challenges.	R, U	1, 7
CO-2	Gain a comprehensive understanding of various renewable energy sources and their applications.	U, An	1, 7
CO3	Develop expertise in energy efficiency practices, energy auditing techniques, and sustainable transportation solutions to address environmental challenges, enhance resource conservation, and promote sustainable development.	U, Ap, An	1, 2, 7
CO4	Acquire comprehensive knowledge and practical skills in waste management strategies and water conservation techniques to mitigate environmental pollution, promote resource efficiency, and contribute to sustainable development goals.	U, Ap, An	1, 2, 7
CO5	Gain a comprehensive understanding of sustainable agriculture and farming practices.	R, U, An	1, 7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Environmental Science IV- Green Technologies
Credits: 4:0:0 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	To impart a foundational understanding of sustainable technologies and their	PO-6, 8/ PSO-1, 7	R, U	F, C	L	-

	applications in addressing environmental challenges.					
2.	Gain a comprehensive understanding of various renewable energy sources and their applications.	PO-2, 6, 8/ PSO- 1, 7	U, An	C	L	-
3.	Develop expertise in energy efficiency practices, energy auditing techniques, and sustainable transportation solutions to address environmental challenges, enhance resource conservation, and promote sustainable development.	PO-2, 6, 8/ PSO- 1, 2, 7	U, Ap, An	C	L	-
4.	Acquire comprehensive knowledge and skills in waste management strategies and water conservation techniques to mitigate environmental pollution, promote resource efficiency, and contribute to sustainable development goals.	PO-2, 6,8/ PSO- 1, 2, 7	U, Ap, An	F, C	L	-
5	Gain a comprehensive understanding of sustainable agriculture and farming practices.	PO-6, 8/ PSO- 1, 7	R, U, An	F, C	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	1	-	-	-	-	-	1	-	-	-	-	-	2	-	2
CO 2	1	-	-	-	-	-	1	-	1	-	-	-	2	-	2
CO 3	1	2	-	-	-	-	1	-	2	-	-	-	2	-	1

CO 4	1	2	-	-	-	-	1	-	1	-	-	-	2	-	1
CO 5	1	-	-	-	-	-	1	-	-	-	-	-	2	-	2

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Assignment topics (Any two)

1. Technological innovations in solar energy systems.
2. Community engagement strategies for promoting sustainable transportation practices.
3. Biomimicry: Learning from nature for sustainable design.
4. Urban planning for sustainable cities and communities.
5. Designing a comprehensive waste management plan for a residential community.

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Tests
4. PowerPoint presentation
5. Poster presentation
6. Quiz/Debate/Discussion

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	-	-	✓
CO 2	✓	✓	-	✓
CO 3	✓	✓	-	✓
CO 4	✓	✓	-	✓
CO 5	✓	-	-	✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK6SECZOO301**				
Course Title	**Ornamental Fish Production and Aquarium Management**				
Type of Course	**SEC**				
Semester	VI				
Academic Level	300 - 399				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	3	2 hours	-	2 hours	4
Pre-requisites	Pass in Class XII				
Course Summary	The present course will equip the student to gain practical skills and theoretical knowledge in ornamental fishkeeping, aquarium design and maintenance, breeding techniques, disease management, and the commercial aspects of the ornamental fish trade, preparing them for careers in aquaculture, pet industry, and related fields. Students develop a holistic understanding of maintaining healthy aquarium ecosystems, breeding ornamental fishes responsibly, managing diseases, and engaging in sustainable practices in the ornamental fish trade.				

Detailed Syllabus

Module	Unit	Content	30 hrs
I		**Introduction to Ornamental fishes**	**9**
	1.1	Ornamental fishes- Scope and Importance, Major freshwater ornamental fish species of India-Indigenous (*Puntius filamentosus.* The Denison Barb-*Sahyadria denisonii* (Miss Kerala), *Horabagrus brachysoma*, and exotic species- Guppy (*Poecilia reticulata*), Gold fish (*Carassius auratus*), Angel fish (*Pterophyllum spp.)* (Brief account only).	4

	1.2	Morphology of Ornamental fishes with special emphasis to sexual dimorphism- *Poecilia reticulata* (Guppy), Siamese fighting fish (*Betta splendens*), Sword tail (*Xiphophorus hellerii).*	2
	1.3	Marine Ornamental Fishes- Blue damsel (*Chrysiptera cyanea*), Clown fish (*Amphiprion ocellaris),* Sea horse (*Syngnathus hippocampus*), Porcupine fish (*Diodon hystrix).* (Brief description)	2
	1.4	Transgenic ornamental fishes- Examples; Glofish; benefits and risks, (Brief account).	1
II	**Setting up of a freshwater Aquarium**		**7**
	2.1	Introduction to aquarium; design and construction of a beginner's freshwater aquarium. Aquarium floor settings-type and size of pebbles, gravels, granites; Aquarium accessories - aerator, diffuser, filters-(biological, chemical and mechanical), lighting, and feeding trays. Common aquarium plants (Brief account only).	4
	2.2	Aquarium system - Optimum water quality (temperature, pH, dissolved carbon dioxide, ammonia, hardness and turbidity), for tropical aquarium fish keeping. Maintenance and control of snails and algal growth.	3
III	**Breeding, Rearing and Nutrition**		**7**
	3.1	Breeding and rearing of common freshwater ornamental fishes with special reference to live bearers (Guppies and Mollies) and egg bearers (Tetras and Barbs), induced breeding and brood stock management (Short description).	5
	3.3	Food and feeding in ornamental fishes. Different kinds of feeds-formulated feed and live feed (Artemia, Infusoria)	2
IV	**Diseases of Ornamental Fishes and their control**		**4**
	4.1	Common disease of ornamental aquarium fishes -viral, bacterial, fungal, protozoan and parasitic -Two examples each with its symptom, treatment and prophylaxis (brief account only).	4
V	**Ornamental Fish Trade: Regulations and Challenges**		**3**
	5.1	Regulations in ornamental fish trade in India (CITES). Trade license issuing authority (Indian Scenario). Green certification.	1
	5.2	Funding and trade supporting organisations: MPEDA, CIFA, CIFRI, NFDB, NBFGR, CMFRI, NABARD, CBD, CIBA, MATSYAFED, KAVIL, FIRMA, Dept of Fisheries and other NGOs. (Brief description only). Entrepreneurship in Ornamental fish culture.	2

References:

1. Ahilan B, Felix N and Santhanam R (2008). Text book of aquaculture. Daya Publishing House, New Delhi.
2. Anshuman D Dholakia (2016) Ornamental Fish culture and Aquarium Management, Astral, Daya Publishing House, New Delhi.
3. Archana Sinha (2021) Breeding and culture of Freshwater Ornamental fishes, New India Publishing Agency, Vikas Surya Plaza, New Delhi.
4. Biswas. S.P, Das J N, Sarkar U K and Lakra W.S (2007) Ornamental fishes of North East India: An Atlas: NBFGR
5. Dey V.K.A (1997). A handbook on aquafarming ornamental fishes. MPEDA, Kochi. Mother Teresa Women's University, Kodaikanal – 624 101.
6. Dholakia, A D (2009) Ornamental fish Culture and Aquarium Management. Daya Publishing House, Delhi, 313pp.
7. Jhingran, V G (1982) Fish and Fisheries of India. Hindustan Publishing Corporation, New Delhi.
8. MPEDA -Living Jewels – A handbook on freshwater ornamental fish, (1990) CIBA library, Chennai.
9. Mukherjee S N, Nanware S S and H S Jagtap (2018) Practical Manual of Pisciculture and aquarium keeping, Daya Publishing House, New Delhi.
10. Mandal S C and Pandey P K(2022), Biology of Freshwater Ornamental Fishes of India, Narendra Publishing House, New Delhi.
11. Santhanam, R. and A. Srinivasan (1994). A Manual of Marine Zooplankton. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
12. Swain SK, Sarangi N and Ayyappan S (2010). Ornamental fish farming. ICAR, New Delhi.

Web resources

- https://www.aquariumcoop.com/blogs/aquarium/how-to-set-up-a-fish-tank
- ornamentalfish.org
- https://ccari.icar.gov.in/Technical%20Bulletin%20No.%2069.pdf
- http://ecoursesonline.iasri.res.in/course/view.php?id=297
- https://www.ofish.org/
- https://krishijagran.com/agripedia/income-generation-by-ornamental-fish- culture/
- https://99businessideas.com/ornamental-fish-farming/

Practicum (30 hrs)

Sl. No.	Contents
1.	Setting up of a freshwater aquarium - Design and construct a small home aquarium using appropriate materials and equipment. OR Set up breeding tanks for livebearer species such as Guppies and Mollies and egg-laying species like Tetras and Danios. Monitor water parameters and document breeding behaviour. (Videos/ Images).
2.	Culture of live feed- Infusorians/ Brine shrimp (Any one) **OR** Artificial feed formulation
3.	Identification of common diseases and parasites of freshwater Ornamental fishes (Any two)

	OR Identification of aquarium accessories and its applications.
4.	Visit to a recognised aquarium (Freshwater/Marine) Identify and describe any three common aquarium plants suitable for different types of aquarium setups and submit a report with geotagged photos. **OR** Visit to any Ornamental fish farm/hatchery and submit a report with geotagged photos.
6.	Identify, classify and describe aquarium fishes with photos (any four). **OR** Study the morphology of different ornamental fish species by examining live specimens or detailed images. Focus on identifying sexual dimorphism in species like *Guppy*, *Betta splendens*, and *Swordtail*. Submit the report with photos.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO1	Understand the major freshwater and marine ornamental fish species, principles of sexual dimorphism, and evaluate the benefits and risks associated with transgenic ornamental fishes.	U, R	PSO-1, PSO1, PSO3
CO2	Create the knowledge and skills necessary to design, construct, and maintain a beginner's freshwater aquarium effectively including appropriate aquarium floor settings, accessories and understand their roles in ensuring optimal water quality and a healthy aquatic environment for tropical aquarium fish.	R, U	PSO5, PSO6
CO 3	Understand the necessary expertise to design, set up, and maintain a vibrant and thriving beginner's freshwater aquarium, fostering a deeper appreciation for aquatic life and ecosystem dynamics.	U, A	PSO1, PSO 6
CO4	Understand the breeding and rearing techniques of common freshwater ornamental fishes, with a special focus on livebearers, egg bearers, induced breeding methods, broodstock management, and hybridization techniques.	An, R	PSO1, PSO2, PSO8
CO5	Equipped with the knowledge and skills necessary to effectively breed, rear, and manage common	An, E	PSO2, PSO5

	freshwater ornamental fishes, contributing to the sustainability and diversity of the ornamental fish industry.		
CO6	Analyse a comprehensive understanding of ornamental fish trade, encompassing their diversity, morphology, habitat preferences, including disease management, regulatory frameworks, sustainability practices, and the role of various stakeholders in promoting a thriving and responsible industry.	An, C	PSO 4
CO7	Develop practical skills in breeding techniques, disease management, and responsible ownership practices, while also gaining insights into emerging trends and ethical considerations within the ornamental fish industry.	Ap, E	PSO5, PSO6

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Ornamental Fish production and Aquarium management
Credits: 2:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1.	Understand the major freshwater and marine ornamental fish species, principles of sexual dimorphism, and evaluate the benefits and risks associated with transgenic ornamental fishes.	PO-1, PSO1, PSO3	U, R	F, C	L	P
2.	Create the knowledge and skills necessary to design, construct, and maintain a beginner's freshwater aquarium effectively including appropriate aquarium floor settings, accessories and understand their roles in ensuring optimal water quality and a healthy aquatic environment for	PO1, PO3/PO6 /PSO5/ PSO6	R, U	P	L	P

	tropical aquarium fish.					
3.	Understand the necessary expertise to design, set up, and maintain a vibrant and thriving beginner's freshwater aquarium, fostering a deeper appreciation for aquatic life and ecosystem dynamics.	PO1, PO6, PSO1	U, A	P	L	P
4.	Understand the breeding and rearing techniques of common freshwater ornamental fishes, with a special focus on livebearers, egg bearers, induced breeding methods, broodstock management, and hybridization techniques.	PO1, PO2, PO6	An, R	P	L	P
5.	Equipped with the knowledge and skills necessary to effectively breed, rear, and manage common freshwater ornamental fishes, contributing to the sustainability and diversity of the ornamental fish industry.	PO6, PO8/PSO 5	An, E	P	L	P
6.	Analyse a comprehensive understanding of ornamental fish trade, encompassing their diversity, morphology, habitat preferences, including disease management, regulatory frameworks, sustainability practices, and the role of various stakeholders in promoting a thriving and responsible industry.	PO1, PO6, PO8	An, C	P, F	L	P
7.	Develop practical skills in breeding techniques, disease	PO6, PO8/	Ap, E	C, P	L	P

	management, and responsible ownership practices, while also gaining insights into emerging trends and ethical considerations within the ornamental fish industry.	PSO5, PSO6				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO 2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO 6**	**P O1**	**PO 2**	**PO 3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO 1	3	-	3	-	-	-	3	-	-	-	-	-	-	-
CO 2	-	-	-	-	3	3	-	-	-	-	-	-	-	-
CO 3	2	-	-	-	-	-	2	-	-	-	-	3	-	-
CO 4	2	3	-	-	-	-	-	-	-	-	-	-	-	2
CO 5	-	1	-	-	2	-	-	-	-	-	-	-	-	-
CO 6	-	-	-	3	-	-	-	-	-	-	-	-	-	-
CO 7	-	-	-	-	2	3	-	-	-	-	-	-	-	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:
Assignment/ Seminar topics

1. Biology of any three Freshwater Ornamental fishes
2. Biology of any three Marine Ornamental fishes

3. Biology of Exotic ornamental fishes (Any Three)
4. Aquarium floor settings and accessories
5. Design and construction of aquarium
6. Induced breeding
7. Transgenic fishes- Risk and Benefits
8. Ornamental fish trade in India-Scope and Challenges
9. Diseases of Ornamental fishes
10. Funding and trade supporting organisations: (MPEDA, CMFRI, NABARD, CBD, CIBA, MATSYAFED, KAVIL).

Continuous Comprehensive Assessment

1. Quiz/ Debate
2. Seminars
3. Assignment
4. Test
5. Submission of report

End Semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4		✓		✓
CO 5		✓		✓
CO 6		✓		

SEMESTER VII

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK7DSCZOO401**				
Course Title	**Instrumentation and Biological Techniques**				
Type of Course	**DSC**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course is designed to impart a strong background on the basic concepts as well as the recent advances in the field of instrumentation and biomedical techniques. The course modules focus on microscopy (Fundamental principle & types), separation techniques (Electrophoresis, chromatography, centrifugation), molecular structure elucidation techniques (Spectroscopy & X-ray crystallography), biomedical techniques and recent advances in informatics.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Microscopy**	**10**
	1.1	**Microscopy –** Principle of microscopy, magnification, resolving power and numerical aperture.	2
	1.2	**Types of microscopes:** Bright field microscope, Dark field microscope, Phase contrast microscope, fluorescent microscope, Stereomicroscope, Confocal microscope, Differential Interference contrast microscope (DIC), Polarised microscope**,** SEM, TEM, Atomic Force Microscope (AFM),	8

		Environmental Scanning Electron Microscope, Confocal Laser Scanning Microscope. (Brief description on the design, Principle and uses only)	
II	**Separation Techniques**		**14**
	2.1	**Electrophoresis:** Electrophoretic mobility (EPM), Factors affecting EPM, Principle and applications of Zone electrophoresis (Paper, Gel, Thin Layer, Cellulose Acetate), Moving boundary electrophoresis (Capillary, Isoelectrophoresis, Immuno Electrophoresis), PAGE.	4
	2.2	**Chromatography:** Partition and Adsorption Chromatography, Paper and Thin layer chromatography, Gel filtration chromatography, Ion-exchange and Affinity chromatography. Brief description of GLC, HPLC, UPLC, FPLC and LC-MS.	6
	2.3	**Centrifugation:** Principle, Refrigerated high speed centrifuge, Preparative centrifuge, Analytical centrifuge, Ultracentrifuge, Dual Asymmetric Centrifuge (DAC), and their applications.	4
III	**Techniques for Macromolecular Structure Elucidation**		**8**
	3.1	**Spectroscopy** - Only the basic principle, Instrumental Design, Methods & Applications of UV–Visible spectroscopy, Beer-Lambert's law; IR & Raman spectroscopy, FT-IR, Attenuated Total Reflectance (ATR), Near Infra-Red Spectroscopy (NIR), Atomic Absorption Spectroscopy (AAS), Inductively Coupled Plasma Mass Spectrometry (ICP-MS), Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES).	5
	3.2	**X –ray crystallography:** Principle and application in molecular structure determination and research.	3
IV	**Biomedical Techniques**		**8**
	4.1	Principle and applications of Angiography, Endoscopy, Fluoroscopy, Medical utility of X-ray imaging, Xeroradiography, Mammography, Myelography.	3
	4.2	Scanning - Ultra sound scanning, CT Scanning, PET, MRI, fMRI.	2.5
	4.3	PCR, RT PCR.	1
	4.4	Blotting- Southern, Western, Northern.	1.5
V	**Recent Approaches in Informatics**		**5**
	5.1	Brief description of Artificial Intelligence (AI), Machine learning, Cloud computing, High performance computing (HPC), Cyber security.	

References

1. Alonso, A. and Arrondo, J. L. R. (2006). Advanced techniques in Biophysics. SpringerVerlag.
2. Baker, E. J. and Silverton, R. E. (1978). Introduction to Medical Laboratory Technology, ELBS.
3. Gupta, A. (2009).Instrumentation and Bio-analytical techniques. PragatiPrakashan, Meerut
4. Chary, K. V. R. &Govil, G. (2008) NMR in Biological Systems. From Molecules to Human. Springer.

5. Drenth, J. (2010) Principles of Protein X-ray Crystallography, Springer
6. Marck, C., Leake (2016). Biophysics; Tools and techniques, CRC Press, Taylor & Francis group.
7. Sandhu, G. S. (1990). Research Techniques in Biological Sciences, Anmol Publications, NewDelhi.
8. Slayter, E. M. (1970). Optical methods in biology. Wiley Interscience.
9. Boobeck. J R (Ed), "Best and Taylor's Physiological basis of Medical Practice", The Williams & Wilkins Co.
10. F.R. Hallett, J.L. Hunt, E.L. McFarland G.H. Renninger, R.H. Stinson and D.E. Sullivan Physics for the Biological Sciences 3rd and 4th Ed.
11. Lakowicz, J. R. (2006) Principles of Fluorescence Spectroscopy. 3rd edition. Springer
12. Banwell, C N. and McCash, E. M. (1994) Fundamentals of Molecular Spectroscopy. 4th Edition, McGraw-Hill.
13. Hollas, J. M. (2004) Modern Spectroscopy. 4th Edition. Wiley.
14. Campbell, I. D. &Dwek R. A. (1984) Biological Spectroscopy. Addison-Wesley.
15. Model, M. L. (2009) Bioinformatics Programming using Python. O'Reilly.
16. Stevens, T. J. and Boucher, W. (2015) Python Programming for Biology Bioinformatics and Beyond. Cambridge University Press.

Web resources

- https://www.ncbi.nlm.nih.gov
- https://microbenotes.com
- https://sist.sathyabama.ac.in

Practicum (30 hrs)

Sl No:	Contents - Any six only
1	Measurement of pH of soil and water samples using pH meter
2	Measurement of microscopic objects using micrometer
3	Serum separation using centrifugation
4	Separation of DNA by agarose gel electrophoresis (Demonstration only)
5	Extractions of nucleic acids from gels (Demonstration only)
6	SDS-PAGE of protein (Demonstration only)

7	Acid – Base titration using pH meter and Determine the pK values: - Strong acid Vs Strong base, Weak acid Vs Strong base, Mixture of Strong and Weak acid Vs Strong base
8	Separation of amino acids using paper/ Thin layer chromatography- Estimate their Rf value
9	Determine the pH titration curve of amino acids & calculate the pKa values
10	Visit any Instrumentation facility (clif Kerala university/CEPCI/ RGCB *etc*.) and submit report
11	Visit to Medical Imaging centres and demonstration of CT Scan, MRI, Ultrasonography, Angiography *etc.*
12	Sketching of biological specimens using Camera Lucida

References

1. Plummer, D. T. (1987) Introduction to Practical Biochemistry. 3rd edition. McGraw-Hill Publishing Co.
2. Holtzhauer, M. (2006) Basic Methods for the Biochemical Lab. 1st English edition. Springer
3. Weaver, R. (2011) Molecular Biology. 5th edition. McGraw-Hill Education
4. Green, M. R. and Sambrook, J. (2012) Molecular Cloning: A Laboratory Manual. 4th edition. CSHL Press.
5. Holtzhauer, M. (2006) Basic Methods for the Biochemical Lab. 1st English edition. Springer.
6. Nadeau, J. L. (2015) Introduction to Experimental Biophysics. CRC Press.

Web resources

- https://sist.sathyabama.ac.in /
- https://www.researchgate.net /

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the fundamental principles, the basic concepts of microscopy and identify the types of microscopes to be used in solving research problem of interest	R, U, Ap, An, C	PSO-1,2,4,5
CO-2	Analyse the principle and concepts of electrophoresis, chromatography and centrifugation.	U, An	PSO-2,3,4,5

CO-3	Apply the types of separation techniques and reflect their role in academic and industrial research.	U, Ap, An	PSO-1,2,3,4
CO-4	Understand and compare the applications of Spectroscopy and X ray crystallography as molecular structure elucidation tools and choose suitable research methodology.	An, E, C	PSO-1,4,5
CO-5	Analyse the suitability of biomedical techniques in disease diagnosis and evaluate their importance.	U, Ap, An	PSO-4,5
CO-6	Appreciate the recent trends in informatics.	Ap, An, E	PSO-5

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Instrumentation and Biological techniques

Credit: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	**CO**	**PO/PSO**	**Cognitive Level**	**Knowledge Category**	**Lecture (L)/Tutorial (T)**	**Practical (P)**
CO-1	Understand the fundamental principles, the basic concepts of microscopy and identify the types of microscopes to be used in solving research problem of interest	PSO-1,2,4,5	R, U, Ap, An, C	F, C, P, M	L	P
CO-2	Analyse the principle and concepts of electrophoresis, chromatography and centrifugation.	PSO-2,3,4,5	U, An	C, P, M	L	P
CO-3	Apply the types of separation techniques and reflect their role in academic and	PSO-1,2,3,4	U, Ap, An	C, P,	L	P

	industrial research.					
CO-4	Analyse the suitability of biomedical techniques in disease diagnosis and evaluate their importance.	PSO-1,4,5	An, E, C	C,P, M	L	P
CO-5	Analyse the suitability of biomedical techniques in disease diagnosis and evaluate their importance.	PSO-4,5	U, Ap, An	C, M	L	P
CO-6	Appreciate the recent trends in informatics.	PSO-5	Ap, An, E	C, M	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO 1	**PSO2**	**PSO3**	**PSO4**	**PSO 5**	**PSO 6**	**PSO 7**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO 7**	**PO 8**
CO 1	3	3	-	2	3	-		2	3	3	2	1	3	1	-
CO 2	-	3	-	3	2	-		1	3	2	2	1	3	1	1
CO 3	2	2	3	3	-	-		2	3	3	3	1	2	1	-
CO 4	3	-	-	3	2	-		1	3	2	1	1	3	-	-
CO 5	-	-	-	-	3	3		1	2	3	1	1	1	2	-

CO 6	-	-	-	-	-	3		1	3	3	1	2	2	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Suggested Topics for Assignment/ Seminar

1. X-ray diffraction (XRD)
2. Basic concepts in medical instrumentation
3. Electron guns in electron microscope
4. Total Internal Fluorescence Microscope (TIRF)
5. Field emission SEM
6. Tungsten filament SEM
7. Types of SEM detectors- BSE, EDS and SED detectors
8. Photoactivated Localisation Microscopy (PALM)

Continuous Comprehensive Assessment

1. Quiz
2. Assignment
3. Internal exam
4. Field report
5. Project report

End Semester assessment

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Essay questions
5. Practical examination

Mapping of COs to Assessment Rubrics:

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓			✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓
CO 6			✓	

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK7DSCZOO402**				
Course Title	**Omics and Bioinformatics**				
Type of Course	**DSC**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course comprehensively explores genomics, transcriptomics, proteomics, metabolomics, and bioinformatics, covering techniques such as genome mapping, gene expression analysis, protein identification, metabolite profiling, and computational biology tools. Students will learn about the applications of these omics technologies in disease research, drug discovery, agricultural studies, and evolutionary biology. The course also emphasises data analysis methods, bioinformatics tools, and challenges in utilising omics data for biological insights and personalised medicine.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Genomics**	**9**
	1.1	Genome mapping types: Genetic and physical maps, methods and techniques used for genetic mapping, physical mapping, the FISH technique in gene mapping, and comparative gene mapping.	2
	1.2	Genome Sequencing Projects and Genomic Techniques and Tools: Human Genome Project, genome sequencing projects for microbes, plants and animals (The Earth Microbiome Project, The International Rice Genome Sequencing Project, The Genome 10K Project).	2
	1.3	Vectors for large-scale genome projects, Clone by-clone strategy, shotgun sequencing, Next Generation Sequencing technologies.	1

	1.4	File formats, Basic pipeline for data analysis Comparative genomics Identification and classification of organisms using molecular markers- 16S rRNA typing/ sequencing, SNPs.	2
	1.5	Data repositories and databases, accessing and retrieving genome project information from the web.	2
II	**Transcriptomics**		**9**
	2.1	Understanding gene expression, differential expression analysis, technologies used microarrays, and next-generation sequencing (NGS).	1.5
	2.2	Tools are available for pathways analysis, gene ontology, hypergeometric enrichment analysis, biogenesis, and the characteristics and analysis of small RNAs like microRNAs and phasiRNAs.	2
	2.3	Analysis of long non-coding RNAs, Target prediction and functional prediction for small RNAs and lncRNAs.	1.5
	2.4	Applications of transcriptomics in disease research, drug discovery, and agricultural research.	2
	2.5	Comparative transcriptomics and its use in Evolutionary biology, Challenge and prospects of transcriptomics.	2
III	**Proteomics**		**9**
	3.1	Identifying and analysing proteins by 2D gel electrophoresis, Isoelectric focusing, Spot visualisation and picking, Tryptic digestion of protein and peptide fingerprinting, Mass spectrometry (MALDI-TOF), Chromatography (LC and GC).	2
	3.2	Functional proteomics- interactions, activities, and localisation in the cell, as well as the networks and pathways in which they are involved.	2
	3.3	Structural proteomics 3D structure of protein determination by NMR and X-ray crystallography; Interaction proteomics -interactions between proteins to understand the complex networks in which they operate.	2
	3.4	Application ofproteomicsin disease diagnosis and prognosis, drug discoveries, basic biological research (understanding cell processes at the protein level), and Agriculture (enhancing stress resistance, nutritional value, and other traits).	2
	3.5	Comparative and integrative proteomics, proteome databases, software packages and tools. Challenges and prospects of proteomics.	1
IV	**Metabolomics**		**9**
	4.1	Metabolite profiling, identifying and quantifying small molecules (< 1kD). Metabolite profiling using MS, NMR, LC, GC.	2
	4.2	Types of metabolites, targeted vs untargeted metabolites.	1
	4.3	Data analysis, pre-processing, statistical analysis, metabolic pathway analysis.	1
	4.4	Applications of metabolomics in Biomarker discovery, Drug development, nutritional studies, environmental toxicology, and plant breeding.	3
	4.5	Five data analysis tools and repositories, data formats and critical challenges and prospects of Metabolomics.	2
V	**Bioinformatics**		**9**
	5.1	Overview of bioinformatics and its applications. Systems biology approaches and modelling. Multi-omics, Integration of omics data for biological insights	2

	5.2	Brief overview of computational biology Introduction to machine learning algorithms- Application of data mining techniques in bioinformatics	2
	5.3	Biological databases, their purpose, primary,secondary, and curated database types with examples, Pairwise and multiple sequence analysis, BLAST, CLUSTAL, FASTA file format.	2
	5.4	Construction of rooted and unrooted phylogenetic trees. Tools and software used in phylogenetic analyses.	1
	5.5	Computational approaches to drug discovery and design (Molecular Docking, MD simulation). Pharmacogenomics and personalized medicine.	2

References:

1. Bagchi D., Swaroop A., (2015),. Bagchi M Genomics, Proteomics and Metabolomics in Nutraceuticals and Functional Foods Wiley Blackwell. ISBN:9781118930427
2. Barh D, Azevedo V, (2017) *Omics Technologies and Bio-engineering: Towards Improving Quality of Life*, Academic Press
3. Barh D., Zambare V., Azevedo V (2013),Omics: Applications in Biomedical, Agricultural, and Environmental Sciences CRC Press. Taylor and Francis Group. ISBN 9781138074750
4. Berna et al. (2014) Nutrigenetics and nutrigenomics insights into diabetes etiopathogenesis. Nutrients.
5. Brown Garland T.A. (2006) Genomes, Science, 3rd Edition,
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11. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
12. Malone et al. (2011) Microarrays, deep sequencing and the true measure of the transcriptome. BMC Biology.
13. Mayer, B. (2011), Bioinformatics for omics data: methods and protocols, New York: Humana Press. ISBN 978-1617790270
14. Primrose S &Twyman R, (2006) Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell,.
15. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006) Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.
16. Robert Weaver (2012)., Molecular Biology, 5th Edition, McGraw-Hill,
17. Sethi et al. (2015) Approaches for targeted proteomics and its potential applications in neuroscience. J. Biosci.
18. Trifonova et al. (2013) Postgenomics diagnostics: metabolomics approaches to human blood profiling. OMICS.

19. Twyman, R(2013). Principles of Proteomics Garland Science, ISBN: 978-0815344728
20. Voet D, Voet JG & Pratt CW, (2006) Fundamentals of Biochemistry, 2nd Edition. Wiley
21. Wilson and Wilsons (2014). Applications of Advances Omics Technologies: from Genes to Metabolites Elsevier. ISBN: 9780444626509
22. Wittmann, C, Lee SY, (2012) *Systems metabolic engineering*, Springer Science & Business Media

Practicum (30 hrs)

Sl No	Contents
1	Familiarising the Databases-National Center for Biotechnology Information (NCBI), Protein Database (PDB), EMBL, DDBJ, OMIM, KEGG.
2	Access and retrieve genomic information from public databases like NCBI to study the genome of a specific organism.
3	Visualize biomolecules (DNA, RNA, Protein) using software (Rasmol and PyMol)
4	Sequence similarity search using NCBI- BLAST.
5	Edit the sequence data using BIOEDIT software.
6	Pairwise and Multiple sequence alignment of DNA and protein sequences using Crustal W/ MEGA.
7	Construction of Phylogenetic tree using MEGA.
8	Downloading and visualisation of the 3-D structure of Protein using PDB.
9	Explore the available MS / NMR spectrum to profile and quantify small molecules in biological samples.
10	Visit to Bioinformatic Research Institutions/Labs

References:

1. Barh D, Azevedo V, (2017) *Omics Technologies and Bio-engineering: Towards Improving Quality of Life*, Academic Press
2. Barh D., Zambare V., Azevedo V (2013), Omics: Applications in Biomedical, Agricultural, and Environmental Sciences CRC Press. Taylor and Francis Group. ISBN 9781138074750
3. Mayer, B. (2011), Bioinformatics for omics data: methods and protocols, New York: Humana Press. ISBN 978-1617790270
4. Voet D, Voet JG & Pratt CW, (2006) Fundamentals of Biochemistry, 2nd Edition. Wiley

Web resources:

- https://www.ncbi.nlm.nih.gov/
- https://www.rcsb.org/
- https://www.embl.org/

- https://www.ddbj.nig.ac.jp/index-e.html
- https://www.omim.org/
- https://www.genome.jp/kegg/
- http://www.openrasmol.org/
- https://pymol.org/
- https://bioedit.software.informer.com/
- https://blast.ncbi.nlm.nih.gov/Blast.cgi
- https://mega.io/
- https://vlab.amrita.edu/?sub=3&brch=311

Suggested assessment Methods

- Group Debates
- Case studies
- Virtual Field Trips
- Collaborative Problem solving
- Interactive Presentations
- Guest Speakers

Field Activities:

- Visit startups in the omics and bioinformatics field.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the principles and techniques of genomics, including genome mapping, sequencing projects, and comparative genomics, to analyse genetic information and study evolutionary relationships.	U, R, An	4,5,7
CO-2	Gain proficiency in transcriptomics, including gene expression analysis, technologies like microarrays and NGS, and tools for pathway analysis and functional prediction, as well as applications in disease research, drug discovery, and evolutionary biology.	U,R, An	4,5,7
CO-3	Develop expertise in proteomics, covering protein separations, quantitative proteomics, mass spectrometry, and structural proteomics, to study protein interactions and cellular processes and their implications for disease diagnosis, drug development, and agriculture.	AP, An,E	4,5,7
CO-4	Acquire knowledge in metabolomics, including metabolite profiling, data analysis techniques, and	AP, An, E	4,5,7

	applications in biomarker discovery, drug development, and environmental studies, to understand metabolic pathways and their roles in biological systems.		
CO-5	Master bioinformatics principles and applications, encompassing omics technologies, systems biology, computational drug discovery, and personalised medicine, to integrate and analyse biological data for insights into complex biological processes and personalized healthcare.	U, AP,An	4,5,7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Omics and Bioinformatics

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the principles and techniques of genomics, including genome mapping, sequencing projects, and comparative genomics, to analyze genetic information and study evolutionary relationships.	PO5,6,7, 8/PSO4, 5,7	U, R, An	C, P, M	L	P
2	Gain proficiency in transcriptomics, including gene expression	PO5,6,7, 8/PSO 4,5,7	U,R, An	C, P, M	L	P

	analysis, technologies like microarrays and NGS, and tools for pathway analysis and functional prediction, for applications in disease research, drug discovery, and evolutionary biology.					
3	Develop expertise in proteomics, covering protein separations, quantitative proteomics, mass spectrometry, and structural proteomics, to study protein interactions and cellular processes and their implications for disease diagnosis, drug development, and agriculture.	PO5,6,7, 8/PSO 4,5,7	AP, An,E	C, P, M	L	P
4	Acquire knowledge in metabolomics, including	PO5,6,7, 8/PSO 4,5,7	AP, An, E	C, P, M	L	P

	metabolite profiling, data analysis techniques, and applications in biomarker discovery, drug development, and environmental studies, to understand metabolic pathways and their roles in biological systems.					
5	Master bioinformatics principles and applications, encompassing omics technologies, systems biology, computational drug discovery, and personalised medicine, to integrate and analyse biological data for insights into complex biological processes and personalized healthcare.	PO5,6,7, 8/PSO 4,5,7	U, AP, An	F, C, P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	-	-	-	3	3	-	3	-	-	-	-	3	3	3	3
CO2	-	-	-	3	3	-	3	-	-	-	-	3	3	3	3
CO3	-	-	-	3	3	-	3	-	-	-	-	3	3	3	3
CO4	-	-	-	3	3	-	3	-	-	-	-	3	3	3	3
CO5	-	-	-	3	3	-	3	3	-	-	-	3	3	3	3

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignments:

1. Human Genome Project
2. The Earth Microbiome Project,
3. The International Rice Genome Sequencing Project,
4. The Genome 10K Project
5. Next-generation sequencing Technologies
6. Multi-Omics
7. Comparative transcriptomics
8. Vectors for large-scale genome projects
9. Comparative and integrative proteomics
10. Integration of omics data
11. Biological Database

Continuous Comprehensive Assessment

1. Assignment
2. Seminar
3. Submission of Reports
4. Submission of Field report
5. Test
6. Quiz
7. Debate
8. Poster preparation & presentation

End semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Type Questions
3. Short Answer Questions
4. Essay Type Questions
5. Practical Examination
6. Viva voce

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment	CCA	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓	✓		✓
CO 4	✓	✓		✓
CO 5			✓	

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK7DSCZOO403**				
Course Title	**Systematics and Phylogenetics**				
Type of Course	**DSC**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course will provide a framework for understanding the diversity of species and their inter- relatedness. Students will learn about the process of systematics in describing, classifying and identifying the diversity of life and acquire the skills required to analyse DNA sequences in a phylogenetic context.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Basic Concepts**	**7**
	1.1	Systematics and Taxonomy – Definition, Historical perspective - Pre-Linnaean, Linnaean and Post –Linnaean taxonomy. Basic principles- Micro, Macro and Integrative taxonomy. Levels of taxonomy- Alpha, Beta and Gamma taxonomy.	3
	1.2	Hierarchy of categories and higher taxa.	1
	1.3	Species and types of species (sibling species, cryptic species, monotypic species, polytypic species).	2

		Different concepts of species- Typological, Nominalistic, Biological, Phylogenetic and Evolutionary species concept.	
	1.4	Importance and applications of Taxonomy and Systematics.	1
II	**Tools and Techniques**		**6**
	2.1	Different types of taxonomic keys– Mention types (dichotomous and polytomous, single access and multi-access, diagnostic and synoptic, computer aided keys). Merits and demerits of keys.	2
	2.2	Types of taxonomic publications – Atlas, catalogue, checklist, field guide, handbook, manual and monographs. Zoological records (brief account only).	1
	2.3	Taxonomic procedures – Collection (wet and dry collection), preservation, curating and process of identification and classification (brief account only).	3
III	**Phylogenetics**		**10**
	3.1	Cladistic analysis - Apomorphy, Autapomorphy, Plesiomorphy, Symplesiomorphy and synapomorphy. Characteristic features of Cladistics. Methodology of cladistic analysis – Construction of cladogram.	3
	3.2	Phylogenetics – Principles – Hennigian Concepts – Significance.	2
	3.3	Phylogenetic relationships–Homology, Homologous sequences of proteins and DNA-orthologous and paralogous. Parsimonyanalysis, nucleotide, and protein sequence analysis. Ancient DNA, DNA polymorphism, Mitochondrial eve and Y-Chromosome Adam.	2
	3.4	Phylogenetic trees- Types, Characters, Character states, Polarity and Rooting of Trees – Construction and Interpretation.	3
IV	**Describing a species**		**14**
	4.1	Taxonomic characters (morphological, ecological, behavioural and embryological)	1
	4.2	International Commission on Zoological Nomenclature (Brief note) and International Code of Zoological Nomenclature (ICZN) Principles of naming.	2

	4.3	Criteria of publication, Criteria of availability.	2
	4.4	Validity of names and nomenclatural acts - Principle of Priority: Synonymy, Spellings, Nomenclatural acts, Precedence, Reversal of precedence.	2
	4.5	Formation and treatment of names	1
	4.6	Authorship, Zoobank	1
	4.7	Principle of Homonymy	1
	4.8	Zoological type – Principles of typification, different kinds of type – Holotype, Paratype, Topotype, Syntype, Lectotype, Paralectotype, Neotype, Allotype.	1
	4.9	Role of Museums and Zoological parks in nomenclature	1
	4.10	Writing diagnosis and description of a species	2
	Modern trends and Approaches in Systematics		**8**
V	5.1	Molecular taxonomy–DNA, RNA and proteins.	3
	5.2	DNA barcoding – Generalprotocol, molecular markers and application in species identification – TheBarcodeof Life Data system (BOLD).	2
	5.3	Phenetics and Cladistics concepts	2
	5.4	Integrative Taxonomy	1

References

- **Systematics**

1. Ashok Verma (2017).Principles of Animal Taxonomy. Narosa. New Delhi.
2. David, M.H., Craig Moritz and K.M. Barbara(1996).Molecular Systematics. Sinauer Associates, Inc.
3. Futyuma, D.J.(1986).Evolution, Systematics and Animal Behaviour. Evolutionary Biology. Sinauer Associates Inc.
4. Kapoor,V.C.(2017).TheoryandPracticeofAnimalTaxonomy.8thedition,OxfordandIBHPublishingCo., Pvt. Ltd. New Delhi.
5. Mayer, E. (2014). Principles of Systematic Zoology. 2nd edition, McGraw Hill book company, Inc.,NY.
6. Mayr, E. &Ashlock, P. D. (1991) Principles of Systematic Zoology (2^{nd} edition) McGraw

Hill Int.
7. Narendran,T.C.(2008). An introduction to taxonomy. Zoological survey of India.
8. Pandit, D.N. (2020). Animal taxonomy: Principles and practices. Narendra publishing house, India
9. SanjibGhoshal (2020). Taxonomy principle and problem. Techno world, Kolkata.
10. Simpson, G.G. (2012).Principles of animal Taxonomy. Scientific Publishers, India.
11. Winston,J.E.(2000).Describingspecies:Practicaltaxonomicproceduresforbiologists. ColumbiaUniversityPress, Columbia, USA.

- **Phylogenetics**

1. Arthur,W.(2011).Evolution –A developmental approach. Wiley-Blackwell, Oxford, UK.
2. Barton,N.H.,Briggs,D.E.G.,Eisen,J.A.,Goldstein,D. B.andPatel,N.H.(2007).Evolution.Cold Spring,Harbour Laboratory Press.
3. Baum D.A and Smith S.D(2012). Tree thinking – An Introduction to Phylogenetic Biology. Roberts and Company Publishers.
4. Dan,G.andLi,W.H.(2000).Fundamentalsofmolecularevolution.(2nd Edn.).SinauerAssociatesInc.MA, USA.
5. DarwinC.D.(1859).On the origin of species by means of natural selection. John Murray, London.
6. Elliott S.(2008).Evidences and evolution:Thelogicbehindthescience.CambridgeUniversityPress,UK.
7. Gould,S.J. (2002). The structure of evolutionary theory. Harvard University Press, MA,USA.
8. Hall, B.K .and Hallgrimsson, B. (2008).Strickberger'sevolution (4th Edn).JonesandBartlettPub.London, UK.
9. Hall,B.K.andOlsen,W.M.,(Ed).(2007).Keywordsandconceptsinevolutionarydevelopmentalbiology.Discoverypublishinghouse, New Delhi.
10. Kimura,M. (1983).The neutral theory of molecular evolution. Cambridge University Press
11. LindellBromham(2016).Anintroductiontomolecularevolutionandphylogenetics,3rd edition,Oxfordpress.
12. Margulis,LynnandM.J.Chapman(2001).KingdomsandDomains:AnIllustratedGuidetothePhylaof Life on Earth (4th edn.).W.H. Freeman&Company,USA.
13. Ridley,M.(2004),Evolution3rdEdition.BlackwellPublishing.
14. Roderick Page,D.M. and Edward Holmes,C.(2009).Molecular Evolution:A phylogenetic approach, Willey Blackwell publisher.
15. Strickberger,M.W.(2000).Evolution. Jones and Bartlett, Boston.

Web Resources:

- http://www.talkorigins.org
- http://www.ucmp.berkely.edu
- https://www.iczn.org/the-code/the-code-online/

Practicum (30 hrs)
(Minimum 6 to be done)

Sl.No.	Contents
1.	Identification of fossils from Models/Pictures
2.	Identification of homology and analogy from suitable specimens- models/ photographs
3.	Comparative study of prokaryote and eukaryote cells by staining and mounting –write notes on evolutionary significance.
4.	Identification of the following using standard keys (any Two groups) and submit a report. A. Insect-5 nos. B. Prawn-2 nos. C. Crab- 2 nos. D. Fishes – 5 nos.
5.	Compilation of data matrix using characters, character states and constructions of classifications which reflect the "relationships" among the taxa. Identification of a taxa using taxonomic key prepared from data matrix.
6.	Construction of Phylogenetic trees with the help of bioinformatic tools(MEGA, PHYLIP- Phylogeny Inference Package) and its interpretation.
7.	Selection of 5 species(preferably invertebrates, insects) belonging to a Clade. Construction of a cladogram using character and character states and illustration, identification and assessment of their relationships.
8.	Comparison of two species of birds belonging to same species but different sub species (Intraspecific difference).
9.	Prepare diagnosis and description of any one fish and insect species using all the taxonomic tools available (for studying new species description).

References

1. Baum D.A and Smith S.D(2012). Tree thinking – An Introduction to Phylogenetic Biology. Roberts and Company Publishers.

2. Lindell Bromham(2016).An introduction to molecular evolution and phylogenetics,3rd edition,Oxford Press.

3. Imms, A.D. (1977). A General TextBook of Entomology. Chapman & Hall, UK

4.Francis Day(1875)- The Fishes of India- Volume I & II, 2018 Edition, MJP Publishers.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the historical development of Systematics from 18th century to the present	U	PSO-1
CO-2	Gain a basic grasp on the rules of nomenclature	R, U	PSO-1
CO-3	Understand the basic principles of Systematics	U	PSO-2,3
CO-4	Understand and apply new trends in Systematics for identification of species	U,Ap	PSO-5
CO5	Analyse the uses and limitations of Phylogenetic trees	U,An, E	PSO-6,7
CO6	Gain the ability to taxonomically describe a species.	R,U,C	PSO-7

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Systematics and Phylogenetics

Credits: 3:0:1 (Lecture:Tutorial:Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand the historical development of Systematics from 18th century to the present	PO-1/PSO-1	U	F, C	L	
2	Gain a basic grasp on the rules of nomenclature	PO-1/PSO-1,2	R,U	P	L	
3	Understand the basic principles of Systematics	PO-6/PSO-1,2	U	C	L	
4	Understand and apply new trends in	PO-6,7/PSO-2,3,6	U,Ap	F,P	L	P

	Systematic for identification of species					
5	Analyse the uses and limitations of Phylogenetic trees	PO-PSO-5,6	U,An,E	F	L	
6	Gain the ability to taxonomically describe a species	PO-3,1,6/PSO-6,7	R,U,C	P	L	

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**
CO1	1	-	-	2	-	-	-	2	-	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	2	-	-	-	1	-	-	1
CO3	3	-	1	-	2	-	-	1	-	1	-	-	-	-	-
CO4	-	-	2	3	-	-	-	-	-	-	2	3	1	-	2
CO5	-	1	-	-	-	2	-	-	2	-	-	2	2	2	1
CO6	1	-	-	3	-	-	3	2	-	3	-	-	3	3	-

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Suggested topics for Assignments/ Seminars: -

1. History of Systematics.
2. Species concepts – advantages and disadvantages
3. Applications of Systematics in Biology.
4. Features of International Code of Zoological Nomenclature.
5. Phylogenetic Tree reading
6. Methods of Cladistic analysis.
7. Collection and Preservation in Invertebrates.
8. Methods of Collection in Vertebrates.
9. Significance of Phylogenetics in biology.
10. Taxonomic keys-different types with advantages and disadvantages.

Continuous Comprehensive Assessment

1. Assignment
2. Seminar
3. Group discussion
4. Submission of Field report
5. Test
6. Quiz

End semester Evaluation

1. Multiple Choice Questions
2. Very Short Answer Type Questions
3. Short Answer Questions
4. Essay Type Questions
5. Viva voce

Mapping of COs to Assessment Rubrics :

	Internal Exam	Assignment/ Seminar	Project report	End Semester Examinations
CO 1	✓	✓		✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4	✓	✓	✓	✓
CO 5	✓		✓	✓
CO 6				

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK7DSCZOO404**				
Course Title	**Human Physiology: The Life Sustaining Systems**				
Type of Course	**DSC**				
Semester	VII				
Academic Level	400 - 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in class XII				
Course Summary	The course imparts in depth knowledge about the structure and functions of different systems in man and provides an understanding of the various disorders associated with them. The course enables the students to understand the various techniques used in monitoring physiological functions.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Nutritional Physiology**	**5**
	1.1	Balanced diet, malnutrition disorders (PEM, marasmus, kwashiorkor), deficiency of iron, iodine and calcium, vitamin deficiencies (xerophthalmia, osteomalacia, beriberi, pellagra)	2
	1.2	Neuroendocrine control of digestion (myenteric and submucus plexus, gastrin, secretin, cholecystokinin, somatostatin, serotonin)	2
	1.3	Eating disorders- obesity, anorexia, hyperphagia, aphagia, bulimia nervosa (brief account)	1
II		**Respiratory and Circulatory physiology**	**11**
	2.1	Haemoglobin- structure and types, transport of oxygen and carbon dioxide- oxygen dissociation curve, Haldane effect, Bohr effect. Respiratory problems in high altitude and deep sea (brief account)	4
	2.2	Respiratory disturbances –brief account on apnoea, dyspnoea, hypoxia, hypo and hypercapnia, asphyxia, carbon monoxide poisoning, bronchitis, asthma. Spirometry (brief account).	2
	2.3	Composition of blood, haemopoiesis (brief account) Blood clotting system- extrinsic and intrinsic pathways, Kallikrein-Kinninogen system (brief explanation), complement system and fibrinolytic system, anticoagulants-endogenous and exogenous.	3
	2.4	Nervous and chemical regulation of heart rate- Frank-Starling law of the heart. Electrocardiogram, blood pressure.	2

III	**Muscle Physiology**		**7**
	3.1	Ultrastructure of striated muscle fibre, muscle proteins. Physiological and biochemical events in muscle contraction-sliding filament theory, actomyosin complex, source of energy for muscle contraction, Cori cycle, role of calcium, mechanism of relaxation.	4
	3.2	Brief account on isometric and isotonic contraction, simple muscle twitch, summation, tetanus, tonus, all or none law, fatigue, oxygen debt, rigor mortis, fast and slow twitch muscles, red and white muscles.	3
IV	**Nerve Physiology and sense organs**		**12**
	4.1	Nerve impulse propagation- voltage-gated ion channels, sodium–potassium pump, hyperpolarization, propagation of action potential, saltatory conduction, neural coding.	2
	4.2	Synapse and synaptic transmission- electrical, chemical and mixed types, neurotransmitters (acetylcholine, amino acids, neuropeptides), cessation of signal and neuromodulators.	3
	4.3	EEG and its significance.	1
	4.4	Nerve disorders-epilepsy, Alzheimer's disease, Parkinson's disease, amnesia, autism, dementia, Huntington's disease, multiple sclerosis, (brief description).	2
	4.5.	Physiology of vision, photochemistry of vision, eye defects - myopia, hyperopia, presbyopia, astigmatism, cataract. Structure of ear and mechanism of hearing, hearing impairments - deafness, labyrinthine disease. Olfactory, gustatory and tactile sense organs.	4
V	**Renal Physiology and Endocrinology**		**10**
	5.1	Structure of nephron, urine formation, regulation of kidney functions. Renal disorders - nephritis, haematurea, renal calculi, acidosis and alkalosis. Dialysis and kidney transplantation.	4
	5.2	Hypothalamus as neuroendocrine gland - principal nuclei involved in neuroendocrine control of anterior pituitary and the hormones.	3
	5.3	Chemical nature of hormones-steroid hormones, biogenic amines, peptide hormones, mechanism of hormone action- peptide, steroid and thyroid hormones, amplification of hormone action (brief account).	3

Practicum (30hrs)

(Students are expected to perform any two major and any three minor practicals)

Sl. No.	Contents
1	Determination of ABO blood group of man. (minor)
2	Enumeration of RBC. (Major)
3	Enumeration of WBC. (Major)
4	Differential count of WBC. (Major)
5	Bleeding time test (Duke's method) (Minor/demonstration)
6	Determination of clotting time. (Minor)
7	Determination of concentration of urea. (Minor)
8	Determination of concentration of uric acid. (Minor)
9	Estimation of acetylcholine content in tissue sample. (Major)
10	Effect of temperature /pH on salivary amylase activity (Major)
11	Kymograph apparatus and explanation of simple muscle twitch (demonstration).
12	Colour blindness test using the Ishihara test. (minor)

References

1. Best and Taylor. (1990). Physiological basis of Medical Practice. Wilkins Co.
2. Delhi.
3. Eckert, R. and D. Randell. (1987). Animal Physiology, CBS Publishers and Distributors N.
4. Ganong, W.F. (2003), Review of Medical Physiology, McGraw Hill, New Delhi.
5. Guyton AC and Hall JE (eds.) (2000) Textbook of Medical Physiology, 10th edition. W.B. Saunders Co., Philadelphia, PA.
6. MacGraw Hill Publishing Co., New Delhi.
7. Physiology https://www.physiology.org/career/teaching-learning-resources/student-resources/what-is-physiology?SSO=Y
8. Physiology News, Researchhttps://www.news-medical.net/?tag=/
9. Sreekumar, S. (2010) Basic Physiology, PHI Learning Pvt. Ltd., New Delhi.
10. Tortora, G.J. and Grabowski, S.R. (eds.) (2000) Principles of Anatomy and Physiology, 9th edition. John Wiley & Sons, Inc., New York, NY.
11. Vander, A.J., Sherman, J.H. and Luciano D.S. (1998), Human Physiology,
12. WHO, Nutrition. https://www.who.int/health-topics/nutrition#tab=tab_1

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	The study helps the students to understand the physiology of different organ systems in the human body.	U	PSO-1
CO-2	Students learn the correlation between diseases and the abnormal structure or improper functions of organs	R, U	PSO-3
CO-3	Students develop basic experimental skills in conducting physiological experiments	U, Ap	PSO-6
CO-4	The students could apply their knowledge of physiological principles to analyze and solve problems related to human health and disease.	Ap, An	PSO-6
CO-5	The students gain awareness of the measures to be taken to maintain good health.	C	PSO-3

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Human Physiology: The Life Sustaining Systems

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)

1	The study helps the students to understand the physiology of different organ systems in the human body.	PO1/ PSO1	U	C	L	
2	Students learn the correlation between diseases and the abnormal structure or improper functions of organs	PO1,PO3 /PSO3	R,U	F,C	L	P
3	Students develop basic experimental skills in conducting physiological experiments	PO6/PSO6	U, Ap	C, P	L	P
4	The students could apply their knowledge of physiological principles to analyze and solve problems related to human health and disease.	PO6/PSO6	AP	F,P	L	P
5	The students gain awareness of the measures to be taken to maintain good health.	PO1,PO2 /PSO3	C	F,P	L	P

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of Cos with PSOs and Pos

	PSO 1	**PSO 2**	**PSO 3**	**PSO4**	**PS O5**	**PSO 6**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**

CO 1	3	-	-	-	-	-	3					
CO 2	-	-	2	-	-	-	3		1			
CO 3	-	-	-	-	-	2						2
CO 4	-	-	-	-	-	1						2
CO 5			2				2	2				

Correlation Levels:

Level	Correlation
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ seminar topics

1. Nutritional components of human food
2. Vitamin deficiency diseases: symptoms and diagnosis
3. Absorption of nutrients in the alimentary canal
4. Types of muscles in men
5. Control of respiration in man
6. Cardiovascular diseases in men
7. The human brain: structure and functions
8. Endocrine disorders in men: causes and symptoms

Continuous Comprehensive Assessment

1. Assignments
2. Seminars
3. Test
4. Model preparation

End Semester evaluation

1. Multiple choice questions
2. Very short answer questions
3. Short answer questions
4. Essay type questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Assignment	Project Evaluation	End Semester Examinations
CO 1	✓			✓
CO 2	✓	✓		✓
CO 3	✓			✓
CO 4		✓		✓
CO 5		✓		✓

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK7DSEZOO401**				
Course Title	**Research Methodology and Biostatistics**				
Type of Course	**DSE**				
Semester	VII				
Academic Level	400 – 499				
Course Details	Credit	Lecture per week	Tutorial per week	Practical per week	Total Hours/Week
	4	3 hours	-	2 hours	5
Pre-requisites	Pass in Class XII				
Course Summary	This course is designed to provide the student a comprehensive knowledge and understanding on various aspects of research methodology and biostatistics. Modules 1 and 2 on Research Methodology covers research design, data collection, analysis, interpretation, and documentation. Module 3 covers descriptive statistics, probability distributions, and sampling methods. Module 4 focuses on statistical inference, including hypothesis testing, sample size determination, and correlation/regression analysis. Module 5 explores advanced biostatistical topics like survival analysis and meta-analysis. Through theory and practical sessions, students learn statistical software and develop research skills. Ultimately, students are equipped to conduct rigorous research in biostatistics and healthcare.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Research Methodology**		**8**
	1..1	**Overview of Research Methodology**: Definition, meaning, objectives and significance of research; Types of research – Descriptive, Analytical, Applied,	**3**

		Fundamental, Qualitative, Quantitative, Conceptual and Empirical Research; Characteristics of good research; Steps of working research.	
	1..2	**Formulation of Research Problem**: Formulation and defining a research problem in Science – Techniques involved, Problem selection and formulation of hypothesis; mention pilot/ preliminary survey and experience survey.	**2**
	1..3	**Research design**: Meaning, Need and features of a good research design; types of research designs (exploratory, descriptive, diagnostic and hypothesis-testing) (*brief account with examples*).	**1**
	1.4	**Execution of research plan**: Data collection, Methods for collection of Primary data (Survey, Questionnaire, Interview, Interview through Phone call) and Secondary data; Analysis of data and Interpretations.	**2**
II	**Research Extension and Ethics**		**9**
	2.1	**Scientific documentation**: Types of Research Publication/ reports (Journals, Books, Book Chapters, Government Reports, Research Articles in Journals, Short Communications, Correspondence, Review articles, Thesis, Dissertations, Proceedings); Characteristics and format – Writing and preparation of articles for publication and for oral and poster presentation; writing a good project proposal; Significance of report writing.	**5**
	2.2	Extension tools, Google scholar, ResearchGate, Orcid, Inflibnet; impact factor, journal indexing, citation index, Scopus, Web of Science, UGC CARE List, h-index; Predatory Journals; Research misconduct: Fabrication, Falsification and Plagiarism; Common Plagiarism checking software (DrillBit, Turnitin, Urkund), ESO standards for safety; IACUC, control of hazards, ethical norms; codes and policies for research ethic; laws related to research ethics in India.	**4**
III	**Foundations of Biostatistics**		**11**
	3.1	**Biostatistics Overview** – Definition and scope of Biostatistics; Importance and application in biology, healthcare and biomedical research (*brief account only*); Concepts: Population, Sample, Parameter, Constant, Variable, Variate, Data (Primary and Secondary data) and Arrangement of data (arrangement of data in tables and frequency distribution).	**3**
	3.2	**Descriptive Statistics** – Graphical representation of data: Line diagram, Bar diagram (simple, multiple, component/ subdivided), Pie diagram and Histogram	**4**

		only (*definition, steps for plotting the graphs, merits and demerits – working with simple data only*); Measures of central tendency: Mean, Median, Mode (*definition, equation, merits and demerits – working with problems*); Measures of dispersion: Standard deviation and coefficient of variation, variance and standard error. (*definition, equation, merits and demerits – working with problems*).	
	3.3	**Probability Distributions** – Probability basics: events, sample spaces, probability laws; Discrete probability distributions: binomial and poisson distributions; Continuous probability distributions: Normal and Exponential distributions (*Theory only*).	**2**
	3.4	**Sampling Methods** – Probability (Simple random sampling, Systematic sampling, Stratified sampling and Cluster sampling) and Non-Probability sampling. (Deliberate sampling, Convenience Sampling, Judgement sampling and Quota Sampling) (*Theory only*).	**2**
IV	**Statistical Inference in Biostatistics**		**11**
	4.1	**Fundamentals of hypothesis testing**: Null and Alternative hypothesis (*Theory only*); Types of error – Type I and Type II errors; Level of significance.	**1**
	4.2	**Sample size determination** – Methods and factors to consider for estimation of sample size.	**2**
	4.3	**Parametric tests:** Concept; t-test; chi-square test.(*Definition, equation, uses, merits and demerits, Problems).*	4
	4.4	**Non-parametric tests:** Mann-Whitney U test; Wilcoxon signed-rank test (*Definition, equation, uses, merits and demerits*).	1
	4.5	**Correlation and Regression analysis** (*Brief – definition, equation, working with simple problem*).	3
V	5.1	**Advanced Biostatistics**	**6**
	5.2	**Survival Analysis –** Basics of survival analysis – Overview and uses; Dose estimates of toxic effects (LD_{50}, LC_{50}); survival function, hazard function (*Brief Outline only*); Mention Kaplan-Meir estimator for survival curves (*brief account only*).	**3**
		Meta-analysis – Overview of meta-analysis (*Definition, objectives and types*); Methods in meta-analysis: Fixed-effect vs random-effect models (*Brief outline only*); Publication	

		bias, sensitivity analysis, interpretation of meta-analytic results; Challenges and criticism in meta-analysis (*Brief notes*). **3**

References

- **Biostatistics**

1. Agarwal, B.L. (2007). Basic Statistics. New Age international publishers
2. Anoop Kumar (2023). Meta-analysis in Clinical Research: Principles and Procedures. Springer Publications.
3. Bailey, N.T.J (1983). Statistical Methods in Biology. Hodder and Stoughton, London https://archive.org/details/statisticalmetho0000bail_d8l1/page/n1/mode/2up
4. Caswell, F. (1982). Success in Statistics. John Murray Publishers Ltd., London.
5. Danial, W. 2006. Biostatistics: A foundation for Analysis in Health Sciences, John Wiley and Sons Inc., New York.
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9. Gupta, S.P. (2021). Statistical Methods (46th Ed.). Sultan Chand & Sons Publishers, New Delhi.https://www.sultanchandandsons.com/images/BookImages/Chapters/59_Statistical%20Methods.pdf
10. Matthias, E., Julian, P.T.H. and George, D.S. (2022). Systematic Reviews in Health Research. Wiley Blackwell
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12. Ostle, B. and Malone, L. (1988) Statistics in Research: Basic Concepts and Techniques for Research Workers. Iowa State University Press, Ames, Iowa, USA.
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14. Vaman, H.J. and Prabhanjan, T (2023). Classical Survival Analysis. Chapman and Hall (Taylor and Francis), New York
15. Wayne, W.D and Chand, L. (2013). Biostatistics: A Foundation for Analysis in the Health Sciences (10th Ed.). Wiley. https://faculty.ksu.edu.sa/sites/default/files/145_stat_-_textbook.pdf

- **Research Methodology**

1. George, C.T. (2021). Research Methodology and Scientific Writing. Springer Publication. https://doi.org/10.1007/978-3-030-64865-7
2. Kothari, C.R., (2009). Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi. https://ccsuniversity.ac.in/bridge-library/pdf/Research-Methodology-CR-Kothari.pdf

3. Oliver, P. (2005). Writing Your thesis. Vistar Publications. New Delhi.
4. Peter, K.D. (2021). Scientific Research and Methodology: An introduction to quantitative research in science and health. https://bookdown.org/pkaldunn/Book

Online Resources

1. Inflibnet - https://www.inflibnet.ac.in/library/
2. UGC-CARE List - https://ugccare.unipune.ac.in/apps1/home/index

Practicum (30 hrs)

Module	Unit	Contents
I		**Biostatistics (20 hrs)**
	1.1	Familiarising various Biostatistics software – MS-Excel, PH Stat in MS-Excel,VassarStats, SPSS, R program, PAST, Primer, Minitab, Gretl, XL Stat, RevMan.
	1.2	Calculation of Mean, Median and Mode of the given data manually and by using suitable software (eg. MS-Excel).
	1.3	Calculation of Standard deviation and Standard error of the given data manually and by using suitable software (eg. MS-Excel).
	1.4	Preparation of tables, bar diagrams, histogram, and pie diagram using suitable software (eg. MS Excel) using the data provided.
	1.5	Statistical analysis of the given data (t-test; Chi-square test; correlation; regression analysis with graph and equation) using suitable software. e.g., PH Stat. in MS Excel, SPSS).
II		**Research Methodology (10 hrs)**
	2.1	Primary data collection on a given topic using survey method (designing questionnaire).
	2.2	Preparation of a review article using the data provided.
	2.3	Preparation of a Project report based on a given topic.

References

Biostatistics

1. John Walkenbach (2016). Microsoft Excel 2016 bible: the comprehensive tutorial resource. Wiley Publication
2. Excel 2019 All-in-One for Dummies. John Wiley & Sons. https://archive.org/details/excel2019allinonefordummies_201911/page/n5/mode/2up

Online Tools

1. VassarStats - http://vassarstats.net/
2. PAST - https://www.nhm.uio.no/english/research/resources/past/
3. MS-Excel Online Tutorial - https://www.w3schools.com/EXCEL/index.php
4. R – Programming - https://www.r-project.org/
5. SPSS - https://www.ibm.com/spss

Research Methodology

1. Subhash, C.P. and Vikram Kate (2018). Writing and Publishing a Scientific Research Paper. Springer Publications. https://doi.org/10.1007/978-981-10-4720-6
2. Yavuz, A.O. (2012). Handbook of Scientific Proposal Writing. CRC Press.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Students will be able to understand and recall key concepts in Biostatistics and Research Methodology	**U, R**	PSO – 1
CO-2	Students will apply statistical inference techniques learned in the course to analyse real-world biological data.	**Ap**	PSO – 2, 5
CO-3	Students will analyse data using correlation and regression analysis techniques to explore relationships between variables in biological research datasets. They will analyse the results of statistical tests and interpret their implications for research findings.	**An**	PSO – 2, 5, 6
CO-4	Students will critically evaluate research methodologies and ethical considerations in biomedical research. They will assess the appropriateness of research designs, data collection methods, and statistical analyses in addressing research questions and objectives.	**E**	PSO – 2, 5, 6
CO-5	Students will create research proposals, articles, and reports based on the principles learned in the course. They will design research projects, formulate research problems, and select appropriate research designs and	**C**	PSO – 2, 5, 7

	methodologies.		

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

Name of the Course: Biostatistics and Research Methodology

Credits: 3:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand and recall key concepts in Biostatistics and Research Methodology	PSO – 1; PO – 1,2,6	U, R	F, C	L	
2	Apply statistical inference techniques learned in the course to analyse real-world biological data.	PSO – 2, 5; PO – 3, 6, 7	Ap	P	L	P
3	Analyse data using correlation and regression analysis techniques to explore relationships between variables in biological research datasets. They will analyse the results of statistical tests and interpret their implications for research findings.	PSO – 2, 5, 6; PO – 1, 2, 6	An	P		P
4	Critically evaluate research methodologies and ethical considerations in biomedical research. They will assess the appropriateness of research designs, data collection methods, and statistical analyses in addressing research questions and objectives.	PSO – 2, 5, 6; PO – 1, 2, 6, 8	E	C,P	L	P
5	Create research proposals, articles, and reports based on the principles learned in the	PSO – 2, 5, 7; PO –	C	C, P		P

	course. They will design research projects, formulate research problems, and select appropriate research designs and methodologies.	1,2,3,6, 7				

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs

	PSO1	**PSO2**	**PSO 3**	**PSO 4**	**PSO 5**	**PSO6**	**PSO 7**	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**
CO 1	3	-	-	-	-	-	-	1	2	-	-	-	2	-	-
CO 2	-	3	-	-	2	-	-	-	-	2	-	-	1	3	-
CO 3	-	3	-	-	2	2	-	1	2	-	-	-	2	-	-
CO 4	-	2	-	-	2	3	-	2	2	-	-	-	1	-	3-
CO 5	-	2	-	-	3	-	3	1	2	1	-	-	2	2	-

Correlation Levels:

Level	**Correlation**
-	Nil
1	Slightly / Low
2	Moderate / Medium
3	Substantial / High

Assessment Rubrics:

Assignment/ Seminar Topics

Biostatistics

1) Standard Score – Concept and definition
2) Skewness and Kurtosis – Concept and definition
3) ANOVA – Characteristics, advantages and disadvantages

4) Vital Statistics – Introduction, uses and methods of collection
5) Measures of vital statistics – life tables

Research Methodology

1) Online libraries, e-journals, e-books
2) Important Zoology Research Institutes in India
3) Intellectual Property Rights
4) Research as Career
5) Research qualification and Research Fellowships in India

Evaluation Pattern

CCA – Assignment, Seminar, In Class Problem solving, short exam, Field work
ESA – Final Exam, MCQs, Report writing, Problem solving using computer

Continuous Comprehensive Assessment (CCA)

1. Assignments
2. Seminar
3. Preparation and Submission of model Project report
4. Solve Biostatistics Problems using suitable software
5. Test
6. Quiz

End Semester Evaluation (ESE)

1. Multiple Choice Questions
2. Very Short Answer Questions
3. Short Answer Questions
4. Essay Type Questions

Mapping of COs to Assessment Rubrics

	Internal Exam	Seminar/ Assignment	CCA	End Semester Examinations
CO 1	✓		✓	✓
CO 2	✓	✓	✓	✓
CO 3	✓	✓	✓	✓
CO 4		✓	✓	✓
CO 5			✓	✓