SEMESTER I

University of Kerala

Discipline	**ZOOLOGY**				
Course Code	**UK1DSC ZOO101**				
Course Title	**Non- Chordate Diversity -Part 1**				
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 acoelomate to pseudo coeolomate. By the end of the course, provides the students to a comprehensive understanding of the diversity, biology, and ecological significance of invertebrate animals, as well as an appreciation for their crucial role in the natural world.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I	**Fundamentals of taxonomy and body plans of animals**		**6**
	1.1	Taxonomy, nomenclature, principles of nomenclature, International Code of Zoological Nomenclature (ICZN), uni, bi and trinomialism	2
	1.2	Five kingdom classification, Three domain system, Super- group model of Eukaryotes, Tree of Life approach in animal classification (Brief account)	2
	1.3	Levels of organization- cellular, tissue, organ and organ system. Radiata, Bilateria, Acoelomata, Pseudocoelomata, Eucoelomata, Protostomia, Deuterostomia	2
II		**Protista and Parazoa**	**14**
	2.1	General characters of Protista, Parazoa and Metazoan	2
	2.2	Zoological importance and systematic position of *Noctiluca, Parameciu*m and *Trichonympha*.	2
	2.3	Parasitic protozoans - Morphology, life cycle, pathogenicity and prophylaxis of *Plasmodium vivax* and *Tripnosoma gambiense.*	4
		Porifera	
	2.4	Porifera-General Characteristics and classification up to classes	1
	2.5	Calcispongia: eg. *Sycon*; Hydrospongia: eg. *Euplectella*: Demospongia, eg. *Spongilla*.	3
	2.6	General topic: Canal system in sponges	2
III	**Cnidaria and Ctenophora**		**8**

	3.1	Cnidaria-General characteristics and classification up to classes- Hydrozoa eg. *Obelia*, *Physalia*; Scyphozoa: eg. *Aurelia* ; Anthozoa: eg. Sea anemone	4
	3.2	General topic: Polymorphism in Cnidarians; Corals - different types, Coral reefs	2
	3.3	Ctenophora-General characteristics and Evolutionary significance of Ctenophora, Plurobranchia (Brief account).	2
IV	**Platyhelminthes and Nemathelminthes**		**9**
	4.1	Platyhelminthes-General characteristics and classification up to classes	1
	4.2	Turbellaria: eg. *Planaria*, Trematoda: eg. *Fasciola*, Cestoda: eg. *Taenia solium*. General topic: Life cycle and pathogenicity of *Faciola hepatica* and *Taenia solium*	4
	4.3	Nemathelminthes - General characteristics : Eg.*Caenorhabdites elegans* General topic: Human nematode parasites (*Ascaris*, *Enterobius*, *Ancylostoma*, *Wuchereria* and *Trichinella*).	4
V	**General topics**		**8**
	5.1	Evolutionary history and phylogeny of Non chordates	3
	5.2	Regeneration in Cnidaria and Platyhelminthes	2
	5.3	Ecological Significance of Invertebrates (Up to Phylum Platyhelminthes)	3

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,R, An, Ap, E,C	PSO-1,3
CO-2	Understand the diagnostic characters of different phyla through brief studies of examples.	U,R, An, Ap, E,C	PSO-1, 3
CO-3	Obtain an overview of polymorphic form, evolutionary significant and parasitic invertebrate especially acelomata to pseudocelomata	U,R, An, Ap, E,C	PSO-1, 4
CO-4	Apply identification skill, to observe and categorise organism	U,R, An, Ap, E,C	PSO-6
CO-5	Understand the faunal diversity of various ecosystems	U,R, An, Ap, E,C	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 U,R, An, Ap, E,C	F	**L**	
CO-2	Understand the diagnostic characters of different phyla	PO-2, 3 PSO -1, 3	U,R, An, Ap, E,C	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	U,R, An, Ap, E,C	F,C	**L**	

CO-4	Apply field identification skill to categorise organism	PO6 PSO -6	U,R, An, Ap, E,C	F,C,P		**P**
CO-5	Understand the faunal diversity of various ecosystems	PO-2 PSO -6	U,R, An, Ap, E,C	F,C,P		**P**

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

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

Mapping of COs with PSOs and POs

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 vivax*	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
		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

III	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

Barnes, R.D. (1987). Invertebrate Zoology. W: B. Sunders. New Delhi.

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

Ekambaranatha Ayyar M. (1990). A Manual of Zoology. Vol. Invertebrata- Part1 & Part II. S. Viswanathan Printers and Publishers. Pvt. Ltd.

Jordan, EL and Verma, P.S. (2000). Invertebrate Zoology. S. Chand and Co Ltd. New Delhi

Kotpal, R. L. (2005). Modern text book of Zoology Invertebrates (Animal Diversity-I). Rastogi Publications pp 795-831.

Rastogi V. B. (2015). Invertebrate Zoology. Publisher- Kedar Nath Ram Nath.

Practicum **Credit : 1 (30 Hrs)**

Sl No	Topic
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

Verma, P. S. (2015). A Manual of Practical Zoology Invertebrates. S. Chand & Company Pvt. Ltd. Ram Nagar, New Delhi-110055.

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	R, U, Ap, An, E, C	PSO-1,3
CO-2	Understand the diagnostic characters of different phyla through examples.	R, U, Ap, An, E, C	PSO-1, 3
CO-3	Obtain an overview of general characters of Nemathelminthes and their parasitic adaptation	R, U, Ap, An, E, C	PSO-1, 3
CO-4	Develop skill to identify and categorise organism	R, U, Ap, An, E, C	PSO-6
CO-5	Gain knowledge about the life cycle of human parasites	R, U, Ap, An, E, C	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	PO - 1,2,3,4	U	F	L	

	classification	PSO-1, 3				
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 about the life history of human parasites	PO - 2,3,4 PSO -1,2	U, Ap	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	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**		**12**
	1.1	Definition of Wildlife, Values of Wildlife	2
	1.2	Need of Wildlife Conservation	1
	1.3	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.	7
	1.4	Ecological significance of Keystone species, Edge species and Umbrella species	2
II	**Wildlife Conservation Strategies And Monitoring**		**14**
	2.1	*In-situ* conservation -National Parks, Biosphere reserves, Wildlife Sanctuaries, Mangrove forests with examples in India and Kerala (Brief description)	5
	2.2	*Ex-situ* conservation- Zoological Parks with examples in India and Kerala, Captive breeding (Brief description with examples)	4
	2.3	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).	5
III		**Wildlife Management And Policies**	4

	3.1	IUCN Red Data Book	1
	3.2	Project Tiger, Project Elephant, Project Cheetah, Project Rhino and Project Crocodile (brief account)	2
	3.3	Indian Wildlife (Protection) Act, 1972; Biological Diversity Act of 2002 (brief account)	1
IV	**Threats to Wildlife**		**8**
	4.1	Major threats to Wildlife: Habitat loss and fragmentation, Over exploitation, Climate change, Poaching, Pollution	3
	4.2	Invasive species. (Eg.-Apple Snail (*Pomacea canaliculata*)	2
	4.3	Man-animal conflict and its management	3
V	**Wildlife Conservation-Organizations and Agencies**		**7**
	5.1	Wildlife conservation organizations, agencies and schemes - WWF, Nagar Van Yojana (NVY), BNHS, Wildlife Conservation Society(WCS), IUCN, ASEAN-WEN	4
	5.2	Wildlife Research Institutes- KFRI, KSBB, IIFM, Salim Ali Centre for Ornithology and Natural History(SACON).	3

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	Topic
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 and apply the key concepts and terminology in wildlife conservation.	U, R, Ap	PSO-1
CO-2	Understand and apply major threats to wildlife populations and habitats, such as habitat loss, climate change, and poaching.	R, U, Ap, An	PSO-2, PSO-3
CO-3	Propose management strategies to mitigate human-wildlife conflicts in different contexts.	U, R, Ap, C, E, An	PS0-1,
CO- 4	Evaluate the effectiveness of conservation policies and practices in different regions.	U, R, Ap, C, E, 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, R, Ap, C, E, An	PSO-1,PSO-5, PSO-6

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

Name of the Course: Credits: 4:0:1 (Lecture: Tutorial: Practical)

CO No.	CO	PO/PS O	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
CO-1	Understand and apply the key concepts and terminology in wildlife conservation.	PO1 PSO-1	U, R, Ap	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, Ap, An	F,C	L	
CO-3	Propose management strategies to mitigate human-wildlife conflicts in different contexts.	PO8 PS0-1	U, R, Ap, C, E, An	F,C	L	
CO- 4	Evaluate the effectiveness of conservation policies and practices in different regions.	PO8 PSO-2	U, R, Ap, C, E, 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, R, Ap, C, E, 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	60Hrs
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 Activity: Construction of a model of the human brain showing its parts. (Group Activity). Prepare a flowchart of parts of brain and their functions		
II	**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: Preparation of lists of available drugs and conducting awareness campaigns. Conduct workshops/awareness street play on the impact of drug abuse and addiction. 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	Understand the components of the human nervous system and analyse their structure and functions, and able to classify neurons based on its structure and function.	R, U, Ap, An, E, C	PSO-1
CO-2	Students learn the mechanism of neural co-ordination in the human body and able to differentiate between chemical and electrical transmission, identifying the role of neurotransmitters and gain insight into the reflex arc and reflex actions.	R, U, Ap, An, E, C	PSO-3
CO-3	Understand the interhemispheric differences in brain functions and can apply the knowledge in analysing individual differences in human behaviour.	R, U, Ap, An, E, C	PSO-2
CO-4	Understand and monitoring the brain activity by studying the brain waves and apply the knowledge in measuring the brain activity by various scanning techniques and can evaluate the brain activity.	R, U, Ap, An, E, C	PSO-1
CO-5	The study gives a comprehensive understanding of various drugs and reward circuits and identify various drugs used by drug abusers and how its actions affects	R, U, Ap, An, E, C	PSO-1

	our brain activity.		

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

Name of the Course: 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 components of the human nervous system and analyse their structure and functions, and able to classify neurons based on its structure and function.	PO1/ PSO1	R, U, Ap, An, E, C	C	L	
2	Students learn the mechanism of neural co-ordination in the human body and able to differentiate between chemical and electrical transmission, identifying the role of neurotransmitters and gain insight into the reflex arc and reflex actions.	PO1,PO2 /PSO3	R, U, Ap, An, E, C	F,C	L	
3	Understand the interhemispheric differences in brain functions and can apply the knowledge in analysing	PO1,PO3 /PSO2	R, U, Ap, An, E, C	C, F	L	

	individual differences in human behaviour.					
4	Understand and monitoring the brain activity by studying the brain waves and apply the knowledge in measuring the brain activity by various scanning techniques and can evaluate the brain activity.	PO1,PO2 /PSO1	R, U, Ap, An, E, C	F, P	L	
5	The study gives a comprehensive understanding of various drugs and reward circuits and identify various drugs used by drug abusers and how its actions affects our brain activity.	PO1,PO2 /PSO1	R, U, Ap, An, E, C	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		2					2		2			

3												
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.				

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, Gender DiversityAnd Sexually Transmitted Diseases**		**11**
	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 Queer. **Related activity:** *Develop scripts for skits or role-plays that address issues related to sexual abuse, harassment, and respecting gender diversity.*	3
	4.3	Definition of Sexually Transmitted Diseases with the following examples: Symptoms, Diagnosis, Treatment and Prophylaxis of Syphilis, Chlamydia, Trichomoniasis, Gonorrhoea, Genital herpes and AIDS.	4
V	**Sex Education in India**		**4**
	5.1	Sex Education -Definition, types, Importance of Sex education among youths, scope and awareness programmes.	2
	5.2	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	**Identify, Understand, classify ,Analyse and Apply the knowledge of Holisitic Helath and well being:** 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, A, Ap, E, C	PSO 1
2	**Identify, Understand, classify ,Analyse and Apply the knowledge of Human Reproductive Physiology**: 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.	U, R, A, Ap, E, C	PSO 2
3	**Identify, Understand, classify ,Analyse and Apply the knowledge of Human interference in Reproduction**: Compare different contraception methods and make informed decisions regarding their use based on individual health needs and preferences	U, R, A, Ap, E, C	PSO 1
4	**Identify, Understand, classify ,Analyse and Apply the knowledge of Adolescent Sexuality, Gender DiversityAnd Sexually Transmitted Diseases** : Analyse the processes and ethical considerations involved in pregnancy, abortion and various assisted reproductive techniques understanding their implications for reproductive health and family planning and STDs including their respective symptoms, transmission modes, and risk factors.	U, R, A, Ap, E, C	PSO 3, PSO 8

5	**Identify, Understand, classify ,Analyse and Apply the knowledge of Sex Education:** 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	U, R, A, Ap, E, C	PSO 8
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, A, Ap, E, C	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/ PSO 1/ PSO 2/ PSO 4	U, R, A, Ap, E, C	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/ P SO2/PS O 3	U, R, A, Ap, E, C	F, C	L	-
4	Analyse the processes and ethical considerations involved in pregnancy, abortion and various assisted reproductive techniques understanding Identify and differentiate between common sexually transmitted diseases including their respective symptoms, transmission modes, and risk factors. their implications for reproductive health and family planning.	PO 2/ PO 8/ PSO3/ PSO4	U, R, A, Ap, E, C	C	L	-

5	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 8/ PS O1/PS O2	U, R, A, Ap, E, C	F	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

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	**Annelida**		**6**
	1.1	Annelida- General characteristics and classification (up to classes)	2
	1.2	Polychaeta: eg. *Nereis* (mention *heteronereis*), Oligochaeta: eg. Earthworm. Hirudinea: eg. Leech	2
	1.3	General topic: Vermicomposting	2

II		**Arthropoda**	**14**
	2.1	Arthropoda : General characters, **Prawn (detailed study**)	7
	2.2	Classification up to classes- Suphylum Trilobitomorpha- Class Merostomata eg. *Limulus*; Class Arachnida eg. Scorpion; Class Pycnogonida eg. Nymphon; Subphylum Mandibulata- Class Crustacea **eg.** *Sacculina*; Class Chilopoda eg. *Scolopendra*; Class Symphyla e.g.*Scutigeralla*; Class Diplopoda eg.*Spirostreptus*; Class Pauropoda eg. Pauropus Class Insecta eg. Cockroach (external characters mouth parts, digestive system)	7
III		**Onychophora and Mollusca**	**11**
	3.1	General characters of Onychophora	1
	3.2	*Peripatus* (Evolutionary significance).	2
	3.3	Mollusca: General characteristics and classification (up to classes)	1
	3.4	Monoplacophora: eg. *Neopilina*, Polyplacophora: eg. *Chiton*, Aplacophora: eg. *Neomenia*, Gastropoda: eg. *Pila*, Scaphopoda: eg. *Dentalium*, Pelecypoda*:* eg. *Perna*, Cephalopoda: eg. *Sepia*.	6
	3.3	General topic: Economic importance of mollusca	1
IV		**Echinodermata**	**7**
	4.1	General characteristics and classification (up to classes).	1
	4.2	Asteroidea: eg. *Asterias*, Ophiuroidea: eg. *Ophiothrix*, Echinoidea: eg. *Echinus*, Holothuroidea: eg. *Sea cucumber*, Crinoidea: eg. Sea lily.	3
	4.3	General Topic: Water-vascular system and Larval forms in Echinodermata	3
V		**Nonchordates in Humanwelfare**	**7**
	5.1	Morphology and Social life in bees	2
	5.2	Pearl culture	2
	5.2	Important Research & Development Institutes in Southern India for Apiculture, Sericulture and Pearl Culture	3

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/ nervous system of Cockroach/digestive system of Cockroach (any one).

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 classification and examples of annelids and arthropods, onychophorans ,molluscs and echinoderms with characteristic features and demonstrate the process and importance of vermicomposting,pearl culture in sustainable agriculture and industry.	U, R. Ap	PSO-1,3
CO-2	Compare the adaptations of annelids and arthropods, onychophorans ,molluscs and echinoderms	R, U, An	PSO-1, 3
CO-3	Learn anatomy by applying and acquiring skills in simple dissections and mountings on permitted species and demonstrating projects or new models for classification.	R,U, C	PSO-1, 4
CO-4	Obtain an overview of evolutionary significance of parasitic and economically important species and Apply knowledge in identifying, classifying and categorising non-chordate organism	U, R, Ap	PSO-6
CO-5	Assess the importance of non-chordates in human welfare	U, E	PSO-6

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

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 classification and examples of annelids and arthropods, onychophorans ,molluscs and echinoderms with characteristic features and demonstrate the process and importance of vermicomposting,pearl culture in sustainable agriculture and industry.	U, R. Ap	PSO-1,3
CO-2	Compare the adaptations of annelids and arthropods, onychophorans ,molluscs and echinoderms	R, U, An	PSO-1, 3
CO-3	Learn anatomy by applying and acquiring skills in simple dissections and mountings on permitted species and demonstrating projects or new models for classification.	R,U, C	PSO-1, 4
CO-4	Obtain an overview of evolutionary significance of parasitic and economically important species and Apply knowledge in identifying, classifying and categorising non-chordate organism	U, R, Ap	PSO-6
CO-5	Assess the importance of non-chordates in human welfare	U, E	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 classification and examples of annelids and arthropods, onychophorans ,molluscs and echinoderms with characteristic features and demonstrate the process and importance of vermicomposting,pearl culture in sustainable agriculture and industry.	PO-2/PSO -1,2,4	U, R, Ap	F	L	
CO-2	Compare the adaptations of annelids and arthropods, onychophorans ,molluscs and echinoderms	PO-1,2/PSO -1, 3	R, U, An	F,C	L	
CO-3	Learn anatomy by applying and acquiring skills in simple dissections and mountings on perm itted species and demonstrati ng projects or new	PO-3/PSO -3, 5, 6	R, U, C	F,C,P	L	

	models for classificatio n.					
CO-4	Obtain an overview of evolutionary significant, parasitic and economically important species and Apply identification skill, to observe and categorise organism	PO-6/PSO - 1,2,4.6	R, U, Ap	F,C,P		P
CO-5	Assess the importance of non-chordates in human welfare	PO-6/PSO - 1, 2	U, E	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	-	3	-	-	-	-	-	2	-	-	-	-
CO2	3	-	3	-	-	-	-	-	3	3	-	-	-	-
CO3	-	-	3	-	3	3	-	-	-	-	3	-	-	-
CO4	3	3	-	3	-	3	-	-	-	-	-	-	-	3
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	3

Correlation Levels:

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

Related Activity

A study tour to visit Important Research & Development Institutes in Southern India for Apiculture/ Sericulture/Pearl Culture

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, equipping them with practical skills to address real-world conservation challenges.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Introduction to Wildlife ecology**	**10**
	1.1	Definition and scope of wildlife ecology, Concepts of biodiversity- Genetic, species and ecosystem diversity	2
	1.2	**Ecological Principles**: Population dynamics: Birth rate , Death rate, Biotic Potential, Carrying capacity Community ecology: Species interactions (competition,predation, parasitism, mutualism and commensalism - brief account only)	5
	1.3	Concept of Habitat and Niche, Wildlife corridors, Habitat selection and utilization by wildlife species	3

II	**Wildlife Behaviour and Ecology**		**13**
	2.1	Social Behaviour- Dominance Hierarchy,Territoriality and Home range, Mourning behaviour and musth- eg: Elephant	4
	2.2	Social groups in animals- eg. elephant, Lion	4
	2.3	Role of Pheromones and chemical signaling in wildlife	3
	2.4	Impacts of human activities on wildlife behaviour and ecology.	2
III		**Challenges to Wildlife**	**8**
	3.1	Natural and anthropogenic threats:Climate change, habitat destruction, pollution, Poaching, Illegal Trade and Exploitation of Wildlife	4
	3.2	Invasive species and their impact on native Wildlife Eg : Cane toad, Red-eared slider turtle	2
	3.3	Common Zoonotic diseases and their impact on wildlife (Brief account only)	2
IV	**Wildlife Conservation**		**16**
	4.1	**In-situ and Ex-situ Conservation Strategies**: Types of protected areas (e.g., national parks, wildlife sanctuaries, biosphere reserves)Brief account only **Related activity:** *Field study – Visit to a Zoo/ Zoological Park/ Natural History Museum/National Parks/Sanctuaries/Community Reserves and Submit a detailed report with photographs/ Prepare a list of birds in the Zoo.*	5
	4.2	Conservation status and threats to endangered species (Eg.Nilgiri Tahr) : Conservation efforts for flagship (Eg : Indian Elephant) and keystone species (Great Indian Hornbill)	4
	4.3	Importance of wildlife corridors and buffer zones (brief account only)	3
	4.4	Role of International Conventions and Treaties in wildlife conservationn - CITES, CBD (Brief account only)- Gadgil Commission & Kasturirangan Commission. (Brief account only)	4
V	**Wildlife Management**		**13**
	5.1	**Population managemen**t: census methods, reintroduction, and control strategies.	3

	5.2	**Habitat management:** restoration, enhancement, and fragmentation mitigation.	3
	5.3	**Human-Wildlife Conflict Management**: Causes and mitigation strategies for human-wildlife conflicts.	3
	5.4	Tools and techniques in wildlife management: GPS tracking, camera traps, drones, and telemetry	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.
4. Mohan Pai (2005) The Western Ghats. M/S Narcinva Damodar Naik Margao, Goa.
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,Wild life Behaviour,important conservation strategies , management of wildlife and challenges posed.	U,	PSO-1
CO-2	Apply the knowledge in anlysing the principles and scope of wildlife ecology,Wild life Behaviour,important conservation strategies , management of wildlife and challenges posed and to recommend appropriate actions.	A	PSO-1,PSO-3
CO-3	Analyze the principles and scope of wildlife ecology,Wild life Behaviour,important conservation strategies , management of wildlife and challenges posed the impact of zoonotic diseases and invasive species on wildlife	An	PSO-1,4,5,6
CO-4	Evaluate the principles and scope of wildlife ecology,Wild life Behaviour,important conservation strategies , management of wildlife and challenges posed the impact of zoonotic diseases and invasive species on wildlife .	E	PSO-3,4

CO-5	Develop creative strategies to explore Wild life Behaviour,important conservation strategies , management of wildlife , challenges posed, the impact of zoonotic diseases and invasive species on wildlife. Demonstrate proficiency in Tools and techniques in wildlife management: GPS tracking, camera traps, drones, and telemetry .	C	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,Wild life Behaviour,important conservation strategies , management of wildlife and challenges posed	PO-1,2,3/PSO-1	U	F, C	L	
2	Apply the knowledge in anlysing the principles and scope of wildlife ecology,Wild life Behaviour,important conservation strategies , management of wildlife , challenges posed and to recommend appropriate actions.	PO1,2,3/PSO-1,PSO-3	A	F,C,P	L	

3	Analyze the principles and scope of wildlife ecology,Wild life Behaviour,important conservation strategies , management of wildlife, challenges posed and the impact of zoonotic diseases and invasive species on wildlife.	PO-1,2,4/PSO-1,4,5	An	F	L	
4	Evaluate the principles and scope of wildlife ecology,Wild life Behaviour,important conservation strategies , management of wildlife and challenges posed the impact of zoonotic diseases and invasive species on wildlife.	PO-1,2,3,6/ PSO-3,4	E	F,C,M	L	

5	Develop creative strategies to explore Wild life Behaviour,important conservation strategies , management of wildlife and challenges posed, the impact of zoonotic diseases and invasive species on wildlife. Demonstrate proficiency in Tools and techniques in wildlife management: GPS tracking, camera traps, drones, and telemetry .	PO1, 2,7,8/ PSO1,7	C	F, C,P,M	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	1	1	-	-	-	-	-
CO 2	-	2	-	-	1	2	-	-	1	3	2	-	3	-	-	2
CO3	-	-	2	2	-	-	-	-	2	2	*	2	-	1	-	-
CO 4	-	-	2	3	-	-	-	-	3	2	1	-	-	3	-	
CO 5	2	-	-	-	-	-	2	-	-	3	-	-		-	2	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 the structure, function, and dynamics of aquatic ecosystems and enable the student to understand the classification of aquatic fauna and their adaptations. The goal of this course is to comprehend and investigate the challenges that aquatic ecosystems face as well as their conservation tactics. Techniques for the sustainable use and management of aquatic resources are also covered in the course.				

Detailed Syllabus

Module	Unit	Content	60 hrs
I		**Aquatic Ecosystems**	**12**
	1.1	Introduction, definition and types of aquatic ecosystems (freshwater, marine and brackish water ecosystems)	2
	1.2	Freshwater ecosystems- Lentic and Lotic environments (Pond, Lakes and Reservoirs).	2
	1.3	Marine ecosystems – Intertidal zone, Neritic zone and oceanic zone (Brief description)	2
	1.4	Brackish water ecosystems – Estuaries, backwaters - example Vembanad	2
	1.5	Marine benthic zones- Coral reefs and their significance	2

	1.6	Mangrove ecosystem – Sunderbans and Kunhimangalam, Kannur	2
II	**Fauna of Aquatic Ecosystems**		**12**
	2.1	Classification - Plankton, Nekton , Neuston and Benthos (Brief account only) Adaptations of Planktons, deep sea fishes and marine mammals	6
	2.2	Major Bioindicators- Definition and importance in aquatic ecosystems (plankton, mayflies, mussels)	6
III	**Challenges and Conservation Strategies**		**12**
	3.1	Challenges to Aquatic Ecosystems: Sand Mining, Ocean Acidification, Overfishing, Habitat destruction and Oil Pollution (oil seepage and shipping).	6
	3.2	Conservation Strategies in Aquatic Ecosystem Restoration- Mangrove restoration program, Sea ranching Program, Bioremediation using superbugs, Ramsar sites in Kerala, Marine protected areas (MPAs) – Gulf of Mannar, Sundarbans. (Related Activities- Visit to Mangrove/Ramsar sites)	6
IV	**Utilization of Aquatic Resources**		**12**
	4.1	Bioprospecting of aquatic ecosystems in the field of food, industry, and medicine – Green algal extract, Cytarabin, Single Cell Protein (Spirulina), Chitin.	6
	4.2	Value Addition of Aquatic resources - Nutraceuticals developed by CMFRI (Cadalmin Green Mussel extract and Cadalmin Antidiabetic extract), Value added seafood products from MPEDA (any two), Water hyacinth as value added product (Mention Center for Research on Aquatic Resources, Alappuzha).	6

V	**Sustainable Management - Issues and Innovations**		**12**
	5.1	Integrated Water Resource Management(IWRM)- Ecosystem – based management(EBM).	3
	5.2	Blue economy ,Blue Carbon and Water budget	3
	5.3	Climate change and Aquatic ecosystems- Impact on Biodiversity, Sea level rising, Coral bleaching.	3
	5.4	Innovative Technologies in Management – Remote sensing, GIS and bio- monitoring techniques.	3

References

1. Allan, J.D and Castillo.M.M.2009, Stream Ecology (Second Ed.) Springer, Netherlands
2. Wetzel, R. G. (2001). Limnology: Lake and River Ecosystems (3rd ed.). Academic Press.
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
10. https://mpeda.gov.in/?page_id=933
11. https://www.cmfri.org.in/cmfri-neutracauticals

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Develop a comprehensive knowledge and understand different types of aquatic ecosystems.	R, U, An	PSO-1,2,3
CO-2	Categorize various aquatic fauna and analyse the way they are adapting to the different aquatic habitats.	U, An, E	PSO-1,2,3
CO-3	Evaluate various aquatic ecosystem issues and assess the major conservation strategies used to revitalize aquatic ecosystems.	U, An, E	PSO-1,2,3,7
CO-4	Analyze the bioprospecting potential of aquatic ecosystems, and evaluate various value-added products	An, E, C	PSO-1,3,5,7
CO-5	Understand various issues and apply innovations in Sustainable Blue Economy Management.	U, Ap, An	PSO-1,2,3,7

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)	Practi cam (P)
CO-1	Develop a comprehensive knowledge and understand different types of aquatic ecosystems.	PO-1,2,3 PSO-1,2,3	R, U, An	F, C	L	-
CO-2	Categorize various aquatic fauna and analyse the way they are adapting to the different aquatic habitats.	PO-1,2,3 PSO-1,2,3,4	U, An, E	F, C	L	-

CO-3	Evaluate various aquatic ecosystem issues and assess the major conservation strategies used to revitalize aquatic ecosystems.	PO-1,2,3 PSO-1,2,3,7	U, An, E	F, C	L	
CO-4	Analyze the bioprospecting potential of aquatic ecosystems, and evaluate various value-added products	PO-2,3,6 PSO-1,3,5,7	An, E, C	F, C, P	L	
CO-5	Understand various issues and apply innovations in Sustainable Blue Economy Management.	PO-2,3,6,7 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

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

Correlation Levels:

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

Assessment Rubrics:

Assignment/Seminar topics

1. Types of quatic ecosystems.
2. Importance of bioindicators in aquatic systems with examples.
3. Aquatic adaptations of deep sea fishes.
4. Ramsar sites in Kerala.
5. Impact of Climate change on aquatic ecosytems.

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,	2

		cataract, glaucoma, amblyopia, colour blindness (brief account only)	
	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**		**11**
	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	2
	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	**Pain receptors**		**15**
	4.1	Nociceptors- different types (A-delta fibres, C-fibres, TRP receptors (brief account only)	2
	4.2	Types of pain-acute and chronic pain, neuropathic pain, Psychogenic pain, Phantom limb pain and mirror box, referred and visceral pain	3
	4.3	Clinical abnormalities of pain and other somatic sensations- Hyperalgesia, Thalamic syndrome, Tic Douloureux, Brown- Sequard Syndrome (All Brief account)	2
	4.4	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)	5

	4.5	Pain treatment and management- opioid and non-opioid analgesics, anti- inflammatory drugs, muscle relaxants, Placebo effect, Acupuncture, TENS	3
	Related activity: Identifying useful tips for managing pain		
V	**Cutaneous receptors and proprioceptors**		**8**
	5.1	Touch and pressure receptors- Meissner's corpuscle, Merkel's discs, pacinian corpuscle, Ruffinis's endings (brief account only)	1
	5.2	Thermoreceptors-warm and cold receptors, A-delta fibres and C-delta fibres	1
	5.3	Position senses- muscle spindle and Golgi Tendon Organ (brief account only)	2
	5.4	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".		

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	Understand the physiology, optics of vision and visual effects. Apply the knowledge on problem solving in eye defects and eye care practices. Capacity to analyze the factors responsible for the development of visual defects	U, Ap, An	**PSO- 1,2, 3,4**
CO-2	To understand the structure of ear, mechanism of hearing, hearing disorders, knowledge on how to use hearing aid and cochlear implants, analyze the effect of noise pollution and preventive measures, apply the knowledge on hearing disorders for recommend appropriate treatment and hearing aids	R, U, Ap, An	**PSO- 1,2, 3,4**
CO-3	Examine the mechanisms of gustation and olfaction, analyze their interplay, and apply this knowledge to address chemosensory disorders.	U, Ap, An,	**PSO- 1,2, 3,4**
CO-4	Evaluate pain mechanisms, analyze their clinical implications, and apply knowledge to propose innovative treatment modalities	U, Ap, An, C	**PSO- 1,2, 3,4**
CO-5	Analyze the processes of somatosensation and vestibular perception, apply concepts to explain related disorders, and create solutions to manage sensory challenge	U, Ap, An, C	**PSO- 1,2, 3,4**

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	Understand the physiology, optics of vision and visual effects. Apply the knowledge on problem solving in eye defects and eye care practices. Capacity to analyze the factors responsible for the development of visual defects	PO-1,2/ PSO- **1,2**, **3,4**	U, Ap, An	F, C	L	-
2	To understand the structure of ear, mechanism of hearing, hearing disorders, knowledge on how to use hearing aid and cochlear implants, analyze the effect of noise pollution and preventive measures, apply the knowledge on hearing disorders for recommend appropriate treatment and hearing aids	PO-1,2,/ PSO- **1,2**, **3,4**	R, U, Ap, An	F, C	L	-
3	Examine the mechanisms of gustation and olfaction, analyze their interplay, and apply this knowledge to address chemosensory disorders.	PO-1,2,/ PSO- **1,2**, **3,4**	U, Ap, An, C	F, C	L	-
4	Evaluate pain mechanisms, analyze their clinical implications, and apply knowledge to propose innovative treatment modalities	PO-1,2,3/ PSO- **1,2**, **3,4**	U, Ap, An, C	F, C	L	-
5	Analyze the processes of somatosensation and vestibular perception, apply concepts to explain related disorders, and create solutions to manage sensory challenge	PO-1,2,3/ PSO- **1,2**, **3,4**	U, Ap, An, C	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	3	3	1	1	-	-	-	3	3	-	-	-	-	-	-
CO 2	3	3	1	1	-	-	-	2	2	-	-	-	-	-	-
CO 3	3	3	1	1	-	-	-	2	2	-	-	-	-	-	-
CO 4	3	3	1	1	-	-	-	2	2	2	-	-	-	-	-
CO 5	3	3	1	1	-	-	-	2	2	2	-	-	-	-	-

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	This course provides a comprehensive understanding of global climate change, covering its basic concepts, anthropogenic causes, and the greenhouse effect. It explores the impacts on ecosystems, weather patterns, and species, alongside management strategies such as national missions and environmental audits. International summits, agreements, and future climate projections, including modeling and GIS, are also discussed. Practical activities like identifying environmental indicators and conducting Green Audits enhance learning.				

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Introduction to Global Climate Change**	**9**
	1.1	Basic Concepts- Biosphere, Atmosphere, Weather, Climate, Climate Change.	2
	1.2	Global Climate change (Brief description): Biological Evidences (Examples: Reduction in Krill population of Arctic Ocean, Habitat loss of Asian Elephants). Indicator Organisms of Climate Change (examples)- Earthworm, The Ganges Dolphin, Sharks, Penguins and Tiger). **Related Activities** *Identification of environmental indicators in Climate change (eg: animals) and submission of reports (Lists/pictures).*	7
II		**Causes of Climate Change**	**8**
	2.1	Anthropogenic causes- Burning of fossil fuel, deforestation, urbanization, industry, agriculture and animal husbandry.	4
	2.2	Greenhouse effect: Greenhouse gases, sources, Global warming, depletion of ozone layer and consequences.	4
III		**Impacts and Management measures of Global Climate Change**	**11**

	3.1	**Impacts of Climate Change**: Rising Temperature, Sea level rise, Increased drought, Heat waves, Flooding, Cyclogenesis, Cloud burst, Water and Food scarcity, Health and economic issues, Animal extinction, Animal migration (Concept only). Global Environmental change issues and challenges - *El Nino, La Nina.*	4
	3.2	Preventive measures taken for Climate Change in India: The National Solar Mission, National Enhanced Energy Efficiency, The National Sustainable Habitat Mission, Green India Mission, EIA program, Energy Audit, Green Audit, Carbon footprint analysis (Brief description only). **Related Activity:** *Green Audit- Residence or Campus*	7
IV	**International Summits and Agreements**		**10**
	4.1	**International Summits**: BRICS, G20, G7, ASEAN, SAARC, Indian Science Congress, NATO. Earth Summit-Rio de Janeiro.	5
	4.2	**International Agreements**: The United Nations Framework Convention on Climate Change, UNFCCC, Kyoto Protocol, Paris Agreement. Swedish environmental activist contribution; Greta Thunberg (Brief account).	5
V	**Future Climate: Scenarios and Projections**		**7**
	5.1	Climate modelling, Climate change feedback, GIS, Role of INCOIS and IMD. (Brief account only). **Related activities:** *Preparation of Weather chart (Temperature/Rainfall) - Connect INCOIS, India Meteorological Department*	7

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

- https://incois.gov.in/
- https://youtu.be/1cWwRPJik9s?si=DrNE-tVlM3bSF_1q
- https://mausam.imd.gov.in/
- 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 basic concept of climate change and indicator organism	R,U	PSO-1,2
CO 2	Understand, recognize and evaluate various causes of climate change	R, U, E	PSO-1,2
CO 3	Identify various climate change issues, challenges and management of global climate change and prepare a green audit model of your campus	U,E, C, Ap	PSO-1,2
CO 4	Analyse and evaluate the activities of international summits	U, An,E	PSO-1,2
CO 5	Analyse the future climate scenarios and prepare a weather chart using INCOIS and IMD websites.	U, An, C	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 basic concept of climate change and indicator organism	PO 1/ PSO-1,2	R,U	F, C	L	-
2	Understand, recognize and evaluate various causes of climate change	PO 1, PO 2/ PSO1, PSO 2	R, U, E	F, P	L	--
3	Identify various climate change issues, challenges and management of global climate change and prepare a green audit model of your campus	PO2/ PSO1, PSO 2	U, E, C ,Ap	F	L	-
4	Analyse and evaluate the activities of international summits	PO1, PO2/ PSO1, PSO 2	U, An, E	F, C	L	-
5	Analyse the future climate scenarios and prepare a weather chart using INCOIS and IMD websites.	PO1, PO2/ PSO1, PSO 2	U, An, C	F	L	-

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive
Mapping of COs with PSOs and POs

	PSO1	PSO 2	PSO 3	PSO4	PS O5	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	-	-	-	-	-

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. Green Audit
5. Green House Effect
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	✓	✓		

SEMESTER III

University of Kerala

Discipline	ZOOLOGY				
Course Code	UK3DSCZOO201				
Course Title	**Chordate Diversity - Part 1**				
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 12				
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

Chordate Diversity-Part 1

Theory: Credit - 3 (Total 45 hours)

Module	Unit	Content	45 Hrs
I	**Introduction to Chordates**		**4**
	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).	2
II		**Non-vertebrate Chordates**	**4**
	2.1	**Tunicates:** General characters. **E.g. Star tunicate** (*Botryllus schlosseri*)-Mention salient features, IUCN status and distribution. Retrogressive metamorphosis in ascidian larvae (Brief account only).	2
	2.2	**Lancelets:** General characters. **E.g. European lancelet** (*Branchiostoma lanceolatum*)- Mention salient features, IUCN status, habitat and feeding behaviour.	2
III		**Vertebrate Chordates- Fishes**	**14**
	3.1	**Vertebrates:** An overview of evolution (Brief account only). Key characteristics and significant characteristics of vertebrates.	2
	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).	2
	3.3	**Jawless Fishes (Agnathans):** General characters. **E.g. Pacific hagfish** (*Eptatretus stoutii*) and **Sea lamprey** (*Petromyzon marinus*)- Mention salient features, IUCN status, distribution and habitat.	2
	3.4	**Cartilaginous Fishes (Chondrichthyes):** General characters. **Eg**. **Spadenose shark** (*Scoliodon laticaudus*) and **Marbled electric ray** (*Torpedo marmorata*)- Mention salient features, IUCN status, distribution and habitat. Mention defence mechanism of *Torpedo*.	2
	3.5	**Bony Fishes (Osteichthyes):** General characters. **Eg.Indian mackerel** (*Rastrelliger kanagurta*) and **Live shark sucker** (*Echeneis naucrates)*- Mention salient features, IUCN status, distribution and habitat.	3
	3.6	**Air-breathing Fishes:** Types of accessory respiratory organs in fishes. Brief account on accessory respiratory organs in **Climbing perch** (*Anabus testudineus),* **Walking catfish** (*Clarius batracus*), **European eel** (*Anguilla Anguilla),* and **Banded gourami** (*Trichogaster fasciata).*	3
IV		**Vertebrate Chordates -Amphibians**	**16**
	4.1	**Amphibians:** Origin (Brief account only). Distinguishing characteristics of amphibians (Mention features of Legs, Lungs, Cutaneous respiration, Pulmonary veins and partially divided heart).	3

	4.2	**Modern Amphibians:** **Frogs and Toads (Anurans):** General characters. **Eg. Malabar flying frog** (*Rhacophorus malabaricus*) and **Indian toad** (*Duttaphrynus parietalis)*- Mention salient features, IUCN status and habitat. **Salamanders (Caudatans):** General characters. **Eg. Tiger salamander** (*Ambystoma tigrinum)*- Mention salient features, IUCN status, habitat, neoteny and paedogenesis.	4
	4.3	**Caecilians (Apodans):** General characters. **Eg. Kodagu striped Ichthyophis** (*Ichthyophis kodaguensi)*- Mention salient features, IUCN status and distribution.	3
	4.4	**Osteology of frog**: Structural features of Limb bones, Vertebral column (Mention Typical Vertebra, Eighth vertebra, Nineth Vertebra, Urostyle), Pectoral girdle and Pelvic girdle.	3
	4.5	**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
V		**Fishes - Facts and Fear factors**	7
	5.1	**Fish Migration**: Mention types of migration. Classification of fishes based on migration (Anadromous and Catadromous). Significance and disadvantages of migration. E.g. Migration in **European eel** (*Anguilla anguilla*).	2
	5.2	**Blind Fishes:** General characteristics of cave-dwelling fishes. Short descriptions of **Meghalayan cave fish** (*Neolissochilus pnar*), **Cave goby** (*Typhleotris madagascariensis*), **Blind cave goby** (*Typhleotris mararybe*).	2
	5.3	**Common Indigenous Fishes of Kerala:** Short descriptions of **Denison barb/Miss Kerala** (*Dawkinsia denisonii),* **Gunther's catfish** *(Horabagrus brachysoma)* and **Pearlspot (***Etroplus suratensis*).	1
	5.4	**Diversity of Invasive fishes of India:** A case study on the invasion of the Suckermouth catfish (*Hypostomus plecostomus*). Short descriptions of **Mozambique tilapia** (*Oreochromis mossambicus*), **Common carp** (*Cyprinus carpio*), **Striped catfish** (*Pangasianodon hypophthalmus*), **Orinoco sailfin catfish** *(Pterygoplichthys multiradiatus)* and **Pirapitinga** (Piaractus brachypomus).	2

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

Chordate Diversity-Part 1

Theory: Credit - 1 (30 hours)

Practicum (30 Hours)	
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	Power Point 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 to a Coastal Intertidal Zone or Estuary / Freshwater Fish Diversity Exploration in Rivers or Streams / Visit to a Local Fish Hatchery or Inland Fisheries Station / Visit to a National Park or Wildlife Sanctuary / Visit to Bird Watching Trail in a Wetland or Forest Area / Visit to Zoo or Biological Park

***Student should sketch and label minimum one Diagram each from SI No. 1 to 7 and all items from SI No. 8 in the record. Student should perform any two minor and one major practical in the laboratory.**

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.	R, U, Ap, An, E, C	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.	R, U, Ap, An, E, C	1, 2, 3, 6
CO-3	Understand and analyse the salient features of Tunicates and create awareness of their habitats.	R, U, Ap, An, E, C	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.	R, U, Ap, An, E, C	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.	R, U, Ap, An, E, C	3, 7, 6

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

Note: 1 or 2 COs/module

Name of the Course: 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)
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	R, U, Ap, An, E, C	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	R, U, Ap, An, E, C	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	R, U, Ap, An, E, C	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	R, U, Ap, An, E, C	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	R, U, Ap, An, E, C	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: Quiz/Assignment/Quiz/Discussion/Seminar, Midterm examination, Final examination

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	1. Pass in Class XII or equivalent				
Course Summary	Diversity of Chordates is an undergraduate course that delves 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. They examine the remarkable adaptations that have allowed chordates to thrive in various habitats, from the depths of the ocean to the heights of the skies. 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, 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**	**11**
	1.1	What are chordates – Explain apomorphies	1
	1.2	Outline of Chordate classification (Use cladistic classification with study of apomorphies of each clade)	2
	1.3	Urochordata and Cephalochordata (mention examples)	2
	1.4	Agnatha - Myxinomorphi, Petromyzontomorphi	2

	1.5	Origin and evolution of fishes	1
	1.6	Outline of fish classification	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**		**6**
	2.1	Outline of amphibian classification, Apomorphies of amphibia, Origin and evolution	1
	2.2	Study of skeletal system and respiratory system of frogs,	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 and air (Reptiles & Aves)**		**12**
	3.1	Outline of reptilian classification, Apomorphies of Reptiles	2
	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	1
	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, Tortises and Terrapins	1
	3.7	Outline of avian classification, Apomorphies of Aves, Origin and evolution of birds	2
	3.8	Morphological characters of birds, feathers and plumage, Anatomy – synsacrum and syrinx	1
	3.9	Identification of 10 common birds in the locality, State bird of Kerala and National bird of India	1

IV	**Explorers of fur (Mammals)**		**9**
	4.1	Outline of mammalian classification (orders), Apomorphies of mammalia, Origin and evolution of mammals	1
	4.2	Prototheria – brief description of Platypus and Echidnas	1
	4.3	Theria – Metatheria, brief description of marsupials	1
	4.4	Theria – Eutheria, Characters of placental mammals	1
	4.5	Study of Arboreal mammals and their systematic position; Relationship between Sirenea & Proboscida, Artiodactyla & Cetacea; Primates with macaques and langurs as example	4
	4.6	Dentition in mammals	1
V	**Adaptive Strategies and Functional Innovations**		**7**
	5.1	Migration in fishes	1
	5.2	Accessory respiratory organs in fishes	2
	5.3	Parental care in amphibians	1
	5.4	Flight adaptations in birds	2
	5.5	Aquatic adaptations in mammals	1

Practicum 30 hours

Unit	**Content**	**Hrs**
Chordate investigations		
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	Arrangement and identification of clades from latest chordate tree of life using printed cards and/or animal images.	

Into the land		
6	Identification of vertebrae of frog	
7	Differentiate between Ichthyophis and Uraeotyphlus and prepare note. (Use specimens, if available in the museum. Else collect images or videos for identification.)	
Conquerors of land (reptiles)		
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)	
Conquerors of air (aves)		
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.	
Explorers of fur		
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, An, E, C	PSO-1, PSO-3
CO-2	Understand the origin and evolution of various chordate groups.	R, U, Ap, An, E, C	PSO-1
CO-3	Systematically identify and place an animal under a specific chordate group.	R, U, Ap, An, E, C	PSO-1
CO-4	Identify morphological and anatomical features of various chordates.	R, U, Ap, An, E, C	PSO-3
CO-5	Understand adaptations and innovations in chordate groups	R, U, Ap, An, E, C	PSO-1, PSO-6

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

Note: 1 or 2 COs/module

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.	PSO-1, PSO-3	R, U, Ap	F, C	L	P
CO-2	Understand the origin and evolution of various chordate groups.	PSO-1	R, U	F, C	L	P
CO-3	Systematically identify and place an animal under a specific chordae group.	PSO-1	R, U	F, C	L	P
CO-4	Identify morphological and anatomical features of various chordates.	PSO-3	R, U	F, C	L	P
CO-5	Understand adaptations and innovations in chordate groups	PSO-1, PSO-6	U, An	F, C, P	T	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
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:

- Quiz / Assignment / Presentations / Group discussions on evolution of groups
- Presentations on animal identifications
- Assignments on identification of local biodiversity (fishes, amphibians, reptiles, birds and mammals)
- Final Exam (Short questions and Paragraph 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		✓	✓		✓

Notes:

1. Kindly use the font Times New Roman and Font Size 12
2. The Above template is for a course with 3 credit theory and 1 credit Practicum.
3. Try to Keep 5 Modules in all courses.
4. A Theory Course with 4 Credits shall be divided into 5 modules with 12 lecture hours for each module.
5. A Theory Course with 3 Credits shall be divided into 5 modules with 9 lecture hours for each module.
6. A course with 2 credit Theory and one credit practicum shall be divided into 5 Modules with 12 hours.
7. If BoS want to change the above module wise hour distribution, try to keep the last module as 20 per cent of the total hours of the course.
8. Programme Outcomes (PO) were already distributed and not given in this template.

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**	**7**
	1.1	Origin and history of Ethology, Animal behaviour classification and Analysis of behaviour patterns (Brief Account).	3
	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**	**8**
	2.1	Patterns of Behaviour, Stereotyped Behaviours - Orientation and Reflex. Individual Behavioural patterns: Instinct and Learned Behaviour.	4
	2.2	Associative learning, classical and operant conditioning, Habituation, Imprinting (Brief).	4
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	**Evolution of communication Behaviour**		**12**
	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	2
	4.4	Migration, orientation and navigation; Domestication and behavioural changes. Biological rhythms: types and characteristics	3
V	**Chronobiology**		**8**
	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
	5.3	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	Study of nests and nesting habits of the birds and social insects (Any 2 from Each group).
2	Study of the behavioural responses of wood lice to dry and humid conditions.
3	Study geotaxis behaviour in earthworm/ To study the phototaxis behaviour in insect larvae.(Demonstration)
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.
12. Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. De Coursey (ed). 2004, Chronobiology
13. Biological Timekeeping: Sinauer Associates, Inc. Publishers, Sunderland, MA, USA
14. D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rd Ed) 2002. Insect Clocks: Barens and Noble Inc. New York, USA.
15. Vinod Kumar (2002). Biological Rhythms: Narosa Publishing House, Delhi/ Springer Verlag, Germany. https://ccb.ucsd.edu/the-bioclock-studio/education-resources/basics/part2.html
16. Ethology practical by Vilmos Altbäcker, Márta Gácsi, András Kosztolányi, Ákos Pogány, Gabriella Lakatos, and Péter Pongrácz Copyright © 2013 Eötvös Loránd University

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Examine and critically evaluate the emergence of ideas that have shaped how we observe and collect data on animal behaviour.	R,U, An, E, C,Ap	PSO-1,2
CO-2	Imagine and improve the attitude of beneficiaries in the monitoring of animal responses using suitable activity	R,U, Ap, An, E, C	PSO-1,2
CO-3	Understand the main historical ideas that underpin theories of animal behaviour	R,U, Ap,An, E, C	PSO-2,3
CO-4	Critically review the hypotheses to explain evolution of animal behaviour	R,U, Ap,An, E, C	PSO-1,2
CO-5	Understand and identify different biological rhythms	R,U, Ap,An, 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	R,U, Ap, An, E, C	F	L	
2	Imagine and improve the beneficiaries attitude to monitor the animal responses using suitable activity	PO-1/PSO-1,2	R,U, Ap, An, E, C	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, Ap, An, E, C	F, C	L	
4	Critically review hypotheses to explain animal behaviour	PO-8/PSO-1/PSO-2	R,U, Ap, An, E, C	F, C	L	
5	Understand different methods for collecting data	PO-6/PO-8/PSO-1/PSO-	R,U, Ap, An, E, 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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8
CO 1	2	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 2	1	2	-	-	-	-	-	-	2	-	-	-	-	-	-	-
CO 3	-	2	3	-	-	-	-	-	-	-	-	-	3	-	-	2
CO 4	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	3
CO 5	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 PLUS TWO				
Course Summary	This course provide the students with basic knowledge to understand the physiological processes involved in eating, drinking, learning, memory and sexual behaviour. They gain awareness of the neural and hormonal regulation of body functions and other influencing factors, allowing them to apply this knowledge in daily life to support health and well-being.				

Detailed Syllabus: Body Functions and Regulation

Module	Unit	Content	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: Survey on the identification of individuals with obesity. Conduct awareness programmes 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: Hypothalamic control of thirst, thirst receptors, renin-angiotensin system, 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.		
IV		**Learning and memory**	**19**
	4.1	Learning - definition and types of learning- motor, verbal, concept, discrimination, principles of learning- problem solving, attitude learning	4
	4.2	Early learning discoveries- Pavlov's experiments, Lashley's work, Thompson's work, learning outside hippocampus	4
	4.3	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
	4.4	Neural mechanisms of memory: synaptic plasticity, Hebbian synapses, long term potentiation (LTP), hippocampus and glutamate receptors, engram	4
	4.5	Forgetting: theories of forgetting- interference theory, retrieval theory, weak storage theory	2
	Related activity: Guest talks by neurologists/psychologists focusing on memory retention.		
V	**Sexual behaviour**		**11**
	5.1	Definition of sex, dynamics of sexual behavior- mating patterns based on number of mates and breeding period, external control of sexual behavior- Coolidge effect; external cues	6
	5.2	Neural mechanisms of sexual behavior- brain and sexual behaviour performance circuit, role of hypothalamus, pituitary and gonads- control	4

		of the secretion of sex hormones in male and female, role of pheromones	
	5.3.	Chemical interventions and sexual behaviour – chemicals that target dopamine, serotonin, sexual orientation	1
	Related activity: Conduct guest talks focusing on sexuality development and behaviour.		

Reference Books

1. Kalat, J.W. Biological Psychology.
2. Levinthal, C.F. Introduction to Psychological Psychology.
3. Schneider, A, M., and Tarshis, B. An Introduction to Psychological Psychology. New York:Random House.
4. Coon, D., & Mitterer, J.O. (2007). Introduction to Psychology (11th ed.). New Delhi: Cengage Learning India Pvt. Ltd.
5. Ciccarelli, S.K., Meyer, G.E. (2008). Psychology (South Asian ed.). New Delhi: Durling Kindersley (India) Pvt. Ltd.
6. Psychology by David G Myres
7. https://www.sleepfoundation.org/dreams#:~:text=Dreaming%20is%20part%20of%20healthy,problematic%20if%20they%20occur%20frequently.
8. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4248571/
9. https://www.scires literature.org/Endocrinology/IJCE-ID17.pdf

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 and body weight regulation. They will also gain insight into the causes, consequences, and management strategies for obesity, a major public health concern.	R, U, Ap, An, E, C	PSO-1,2
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, Ap, An, E, C	PSO-1, 2.3.4

CO-3	Understand the biological mechanisms underlying sleep and wakefulness and analyze the significance of circadian rhythms in regulating physiological and cognitive processes in daily life.	R, U, Ap, An, E, C	PSO-2,4
CO-4	Understanding these concepts provides insights into how we learn, remember, and adapt to our environment, forming the foundation of cognitive psychology and neuroscience and apply in their daily life.	R, U, Ap, An, E, C	PSO-2,4
CO-5	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.	R, U, Ap, An, E, C	PSO-1,2,4

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

Name of the Course: 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 feeding behavior and body weight regulation. They will also gain insight into the causes, consequences, and management strategies for obesity, a major public health concern.	PO-1, PO-2/PSO-1,2,4	R, U, Ap, An, E, C	F, C	L/T	

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, Ap, An, E, C	F,C	L/T	
3	Understand the biological mechanisms underlying sleep and wakefulness, as well as the significance of circadian rhythms in regulating physiological and cognitive processes.	PO-2,4/PSO-2,4	R, U, Ap, An, E, C	F,C	L/T	
4	Understanding these concepts provides insights into how we learn, remember, and adapt to our environment,	PO-4,5/PSO-2,4	R, U, Ap, An, E, C	F,C	L/T	

	forming the foundation of cognitive psychology and neuroscience.					
5	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	R, U, Ap, An, E, C	F, C	L/T	

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	-	-	-	-	-	-
CO2	1	2	2	2	-	-	-	-	2	2	-	-	-	-	-	-
CO3	-	2	-	2	-	-	-	-	-	2	-	2	-	-	-	-

CO 4	-	2	-	3	-	-	-	-	-	2	-	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. 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
		Introduction to Vector-borne diseases	**8**
	4.1	Introduction to vector-borne diseases and overview of vectors- mosquitoes, ticks, flies	2

IV	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

References:

1. Advances in Parasitology Vol. 1-4 (2011). Annual Reviews Inc.
2. Azad, A.F (1986). Mites of public health importance and their control. World Health Organization. Division of Vector Biology and Control (1986).
3. Benelli G, Jeffries CL, Walker T (2016). Biological Control of Mosquito Vectors: Past, Present, and Future. Insects. Oct 3; 7(4):52. doi: 10.3390/insects7040052. PMID: 27706105; PMCID: PMC5198200.
4. Bonita R., Beaglehole, R. and Kjellstrom, T. (2006). Basic Epidemiology (Second edition). WHO, Geneva.
5. Burton J. Bogistch, Clint E. Carter, Thomas N. Oeltmann. (2005). Human Parasitology. Third Edition, Elsevier Academic press.
6. Chaterjee, K.D. (1981). Parasitology: Protozoology and Helminthology: Introduction to Clinical Medicine. Ed 12.Chaterjee Medical Publishers.
7. Davis A. Warrell and Herbert M. Gilles. (2002). Essential Malariology, Fourth Edition. Arnold pub. Oxford.

8. Dennis French,Tom Craig, Jerome Hogsette, Jr, Angela Pelzel-McCluskey, Linda Mittel, Kenton Morgan, David Pugh and Wendy Vaala (2016). External Parasite and Vector Control Guidelines, The American Association of Equine Practitioners.
9. Gordis, L. (2018). Epidemiology (Sixth edition.). Philadelphia: Elsevier Saunders
10. Gubler,D.J. E. E. Ooi, S. Vasudevan, J. Farra, Duane J. Gubler, EngEongOoi, SubhashVasudevan, Jeremy Farrar. (Aug. 2014). Dengue and Dengue Hemorrhagic Fever. Ed. 2. CABI
11. Guidelines for integrated vector management for control of Aedes mosquito, Govt of India National Vector Borne Disease Control Programme, Directorate General of Health Services, Ministry of Health & Family Welfare
12. Harwood R.F. and James M.T. (1979). Entomology in Human and animal health. Macmillan Publishing Co.Inc, London. 7 Ed.
13. Ian F. Burgess (2004). Human Lice and their Control, Annu. Rev. Entomol. 49:457–81 doi: 10.1146/annurev.ento.49.061802.123253
14. Kochchar, S.K. (2009). A TextBook of Parasitology. Wisdom Press.
15. Lena Lorenz and Mary Cameron (2013). Biological and Environmental control of Disease vectors. CABI Publishing
16. National ethical guidelines for biomedical and health research involving human participants. New Delhi: Indian Council of Medical Research; 2017.
17. Nutman. (2002). Lymphatic filariasis. Imperial College.
18. Paniker CK, Ghosh S. (2021). Paniker's Textbook of Medical Parasitology, 9/e, Jaypee Brothers Medical Publishers.
19. Park. K. (2023). Park's textbook of preventive and social medicine, 27/e, Bhanot publishers.
20. Rothman K, Greenland S, and Lash TL. Modern epidemiology, 4th Edition. Philadelphia, PA: Lippincott Williams & Wilkins.
21. Sabesan S, Raju KH, Subramanian S, Srivastava PK, Jambulingam P. Lymphatic filariasis transmission risk map of India, based on a geo-environmental risk model. Vector-Borne and Zoonotic Diseases. 2013; 13(9): 657-65.
22. Stephen L. Doggett (2005). Bed bug ecology and control, Pests of Disease and Unease, Australia
23. WHO (2015). Indoor Residual Spraying. An operational manual for indoor residual spraying IRS) for malaria transmission control and elimination,
24. World Health Organization. (2012). Handbook for integrated vector management. World Health Organization. https://apps.who.int/iris/handle/10665/44768

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

References:

1. Imms, A.D. (1977). A General TextBook of Entomology. Chapman & Hall, UK .
2. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson
4. Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press, UK

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	**Identify, Understand, classify ,Analyse and Apply the knowledge of 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.	R, U, An, Ap, E, Cr	PSO-1,2
CO-2	**Understand,Analyse and Apply the knowledge of 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, An, Ap, E, Cr	PSO-1,2,5
CO-3	**Understand,Analyse and Apply the knowledge of 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.	R, U, An, Ap, E, Cr	PSO3,6

CO-4	**Understand,Analyse and Apply the knowledge of 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.	R, U, An, Ap, E, Cr	PSO3
CO-5	**Understand,Analyse and Apply the knowledge of 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.	R, U, An, Ap, E, Cr	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	R, U, An, Ap, E, Cr	F, C	L	P
CO-2	Understand the transmission dynamics of	PSO-1,2,5	R, U, An, Ap, E, Cr	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	R, U, An, Ap, E, Cr	F,C,P	L	P
CO-4	Evaluate vector control strategies and public health	PSO3	R, U, An, Ap, E, Cr	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	R, U, An, Ap, E, Cr		L	

	diverse contexts.					

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	2	3	-	-	-	-	-	1	1	-	-	-	3	-	-
CO2	2	3	-	-	3	-	-	-	-	2	-	-	-	-	-
CO3	-	-	2	-	-	2	-	-	-	-	-	2	-	-	-
CO4	-	-	2	-	-	-	-	-	-	-	3	-	-	-	-
CO5	-	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	45Hrs
I		**Taxonomy of finfishes and shellfishes**	**12**
	1.1	Taxonomic procedures: Collection, identification and preservation of commercially important fishes, crustaceans, and molluscs with special reference to the fauna of Kerala. (One from each category)	5
	1.3	Morphological features and characters used in identification of fishes, prawns, crabs, lobsters, gastropods and bivalves (brief account, follow FAO identification sheets),Truss morphometry in fish.	6
	1.4	Modern taxonomical tools: Karyotyping, DNA barcoding Related activity : Preparation of model of karyotype of any one fish	1
II		**Food and feeding behaviour**	**7**
	2.1	Food and feeding habits of fishes, commercially important crustaceans and molluscs. (Eg Sardine,Penaeus and Sepia). Feeding adaptation, feeding in relation to season, growth, sex and breeding in fishes.	4
	2.2	Methods of studying Food and Feeding habit: Stomach fullness Index, Empty Stomach Ratio, Relative Gut Length, Gastrosomatic Index.	3
III		**Reproductive Biology**	**12**
	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.	4
	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**		**9**
	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) Related activity : Powerpoint presentation on parental care in fishes	5
V	**Age and Growth**		**5**
	5.1	Age determination – Methods employed in age determination, tagging recapture technique, chemical markers, Petersen method, examination of hard parts	3
	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 CompanyLimited, 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. Currie, S. and Evans, D. H. 2021. The Physiology of Fishes.5th Edn. CRC Press. 241pp.
9. DattaMunshi, J.S & M.P. Srivastava 1988. Natural History of Fishes: Systematics of Freshwater Fishes of India. Narendra Publishing Co., New Delhi, 403 pp.
10. Day, F. 1865. The Fishes of Malabar. Quariteb, London, 293 pp.
11. Diana, J, S. and Hook T. O. 2023. Biology and Ecology of Fishes. 3rd Edn. John Wiley&Sons Ltd. 545pp
12. Halver, J.E. 1972. Fish Nutrition. Academic Press, London.
13. Hewitt, G. M., A. W. B. Johnston, and P. R. W. Young, eds. 1991. Molecular Techniques in Taxonomy. Springer-Verlag, Berlin.
14. Hillis, D. M., C. Moritz, and B. K. Mable. 1996. Molecular Systematics, 2d ed. Sinauer Associates, Sunderland, Mass.
15. Hoar, W.S. and D.J. Randall. 1971. Fish Physiology. Vols. I to V. Academic Press, New York.
16. Hoithuis, L.B. 1991. FAQ species catalogue. Marine lobsters of the world. An annotated and illustrated catalogue of species of interest to fisheries known to date. FAO Fisheries Synopsis. FAO. Rome, Vol.
17. Jayaram, K.C. 1999. The Freshwater Fishes of the Indian Region. Narendra Publ. Hse., Delhi, 551 pp.
18. Jhingran. V. G. 1991. Fish and Fisheries of India. Hindustan Publishing Corporation. 727pp.

19. Khanna, S.S., 1993. An introduction to fishes, Central Book Depot, Allahabad, 530 pp.
20. Kottelat, M. & T. Whitten 1996. Freshwater Biodiversity in Asia with Special Reference to Fish. World Bank Technical Paper No.343, The World Bank, Washington.
21. Kurian, C.V. & V.O. Sebastian 1986. Prawns and Prawn Fisheries of India. Hindustan Publ. Corpn., New Delhi, 297 pp.
22. Lagler, K.F., J.E. Bardach& R.E. Miller 1963. Ichthyology. John Wiley & Sons, Inc., NY.
23. Moyle, P.B. and J.J. Cech, 1996. Fishes, an introduction to ichthyology. (3rd Ed.). Prentice Hall, Upper Saddle River, New Jersey, 590 pp.
24. Narendran, T.C. 2006. An Introduction to Taxonomy. Zoological Survey of India, Koltata.
25. New & Barnard. 2010. Freshwater Prawns Biology & Farming. Wiley- Blackwell, London.
26. Raghunath, M.R. 2013. Nutrition and Feeding of Fishes. Swastik Publishing House, Delhi.
27. Simpson, G.G.1969. Principles of Animal Taxonomy. Oxford & IBH Publ. Co., Bombay.
28. Smyth & Lynwood. 2003. Introduction to Fish Physiology. Narendra Publishing House, Delhi
29. Srivastava, C.B.L. 2008. Fish Biology. Narendra Publ. Hse., India, 329
30. Subba Rao, N.V. 2003. Indian Seashells: Part-I: Polyplacophora and Gastropoda. Zoological Survey of India, Kolkata.
31. SurendraNath. 2002. Food, Feeding habits, Alimentary canal and Digestion in fishes: A Bibliography. Vinod Publishers and Distributors, India
32. Talwar, P.K. & V.G. Jhingran 1991. Inland Fishes of India and Adjacent Countries. Vol. 2. Oxford & IBH Publ. Co., New Delhi.
33. Talwar, P.K. & R.K. Kacker 1984. Commercial Sea Fishes of India. Zoological Survey of India, Kolkata, 986 pp.

Practicum Component (Credit :1 30 Hrs)

Practicum		
Sl. No	**Content**	**30 Hrs**
1	Identification of fishes (2) and prawns (2) using standard keys	6
2	Study of external morphology -Fishes-Fins and mounting of Scale –Any 3 types	2
3	Prawn- Identification ofThoracic appendages of marine and fresh water prawn	2
4	Dissect and study the anatomical variations (mouth, teeth, gill rakers, alimentary canal) in digestive system of fish (herbivore, omnivore and carnivore) (Major)	4
5	Estimation of Gastrosomatic Index (Major)	3
6	Dissect male / female reproductive system in teleost (Major)	3
7	Estimation of fecundity and gonadosomatic index in fish (Major)	3
8	Study of larval stages of shellfishes – nauplius, protozoea, mysis, zoea, megalopa, phyllosoma, puerulus, trochophore, veliger (Any five-representing prawn, crab, lobster, and bivalve) (Use preserved specimen/slides/diagram) (Minor)	4
9	Calculate the Length- weight relationship and condition factor of a finfish (Major)	3

***. Student should perform any 3 minor and any 2 major practical in the laboratory.**

References:

1. Day, F. 1878. Fishes of India, Vols. 1 & 2. William Dawson & Sons Ltd., London.
2. Ian.S.R. Munro. 2000. The Marine and Freshwater Fishes of Ceylon. Narendra Publishing House.
3. Josileen Jose and Lakshmi. S. Pillai. 2013. Training Programme on "Taxonomy and Identification of Commercially Important Crustaceans of India". CMFRI.
4. Evans, D.H. 1998. The Physiology of Fishes. 2nd ed. CRC Press, NY
5. Jayaram, K.C. 2002. Fundamentals of Fish Taxonomy. Narendra Publ. Co., Delhi.
6. Khanna, S.S. & H.R. Singh 2006. A Textbook of Fish Biology and Fisheries. Narendra Publ. Hse., India
7. 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.
8. Nelson, J.S. 2006. (4th Ed.). Fishes of the World. John Wiley & Sons, Inc., New Jersey.
9. Jhingran, V.G (1997).Fish and Fisheries of India, Third Edition. Hindustan Publishing Corporation India.
10. 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, taxonomic procedures, morphological characters, conventional and modern methods used for the identification of finfishes and shellfishes	R, U, Ap	1,7
CO2	Understand the diversity of feeding, feeding adaptations and analyse food and feeding habits using gut contents and indices	U, Ap, An, Ev,C	2, 3
CO3	Familiarise reproductive organs, modes and strategies of reproduction and methods to assess reproductive parameters in fishes	U, Ap, An, Ev ,C	1,3
CO4	Understand the development and early developmental stages of cultivable important species	U, Ap, An,C	4
CO5	Evaluate age determination methods , factors affecting fish growth and growth patterns	U, Ap, E ,C	1,3

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

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Understand concepts of taxonomy, taxonomic procedures,	PO-1,2,5 PSO-1,7	R, U, Ap	F,C	L	P

	morphological characters, conventional and modern methods used for the identification of finfishes and shellfishes					
2	Understand the diversity of feeding, feeding adaptations and analyse food and feeding habits using gut contents and indices	PO-1,3,4,5 PSO-2, 3	U, Ap, An, Ev,C	F,P	L	P
3	Familiarise reproductive organs, modes and strategies of reproduction and methods to assess reproductive parameters in fishes	PO-1,2,4,5 PSO-1,3	U, Ap, An, Ev ,C	P	L	P
4	Understand the development and early life history of cultivable important species	PO-7,8 PSO-4	U, Ap, An,C	F,P	L	P
5	Evaluate age determination methods , factors affecting fish growth and growth patterns	PO-1,2,4,6 PSO-1,3	U, Ap, E,C		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	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 1- 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: Entomology 1 – General Entomology

Credit – 4 (45 T+ 30 P)

Module	Unit	Content	45Hrs
I		**Insect Diversity**	**10**
	1.1	Nature and scope of Entomology – Economic importance of insects (*Brief Notes*).	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. (*Brief Notes*)	2
		***Related Activity**: Field visit in College Campus to collect common insects – identify the insects till Order; Quiz on Economic Importance of Insects.*	
II		**Morphology of Insects**	**10**
	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. (*Brief Notes on each*)	4
	2.3	Abdomen – Segmentation, Genitalia in male and female.	1
		***Related Activity**: Group Discussion on 'Comparison of Wings in Insects and Birds. Its Evolutionary significance'*	

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 (*Brief Notes*)	2
	3.6	Insect endocrine system – Brain neurosecretory cells, Corpora cardiaca, Corpora allata and Prothoracic gland.	2
		***Related Activity**: Visit any field (preferably inside college campus) – observe and note insects belonging to various feeding guilds (Herbivores, Detritivores/ Decomposers, Predators, Pollinators)*	
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
		***Related Activity**: Group Discussion on advantages and disadvantages of complete and incomplete metamorphosis. Identify and list at least 5 common insects that undergo complete and incomplete metamorphosis.*	
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
		***Related Activity**: Activity – sprinkle some sugar on ground near ant nest and observe how ants find it and make trails to collect it. Make a note on the pheromones involved.*	

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.
7. Pant, NC. And Ghai (Ed) 1981.Insect physiology and anatomy. Indian Council of Agricultural Research, New Delhi.
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
9. Interactive Key to Insect Orders - https://keys.lucidcentral.org/search/insect-orders/

ENTOMOLOGY 1- GENERAL ENTOMOLOGY – PRACTICUM (30 Hrs)

Sl. No	Content
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 insect 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
3. Interactive Key to Insect Orders - https://keys.lucidcentral.org/search/insect-orders/

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand and recall core entomological concepts, including classification and economic importance. Apply techniques for insect collection and preservation. Analyse traits for classification, evaluate ecological roles, and create scientific records of specimens.	U, R, Ap, An, E, Cr	PSO-1,3
CO-2	Recall and understand the structure and function of insect head, thorax, and abdomen. Apply knowledge to identify and compare morphological adaptations. Analyse structural variations and evaluate their ecological significance. Create anatomical diagrams and records of insect features.	U, R, Ap, An, E, Cr	PSO-1,3,6
CO3	Recall and understand the structure and function of major insect systems. Apply knowledge to identify system components and their roles. Analyse system integration and specialization. Evaluate their adaptive significance. Create diagrams and summaries of insect physiological processes.	U, R, Ap, An, E, Cr	PSO- 4,6
CO4	Recall and understand insect reproductive systems and hormonal control of metamorphosis, moulting, and diapause. Apply and analyse developmental adaptations. Evaluate endocrine roles and create diagrams illustrating key processes.	U, R, Ap, An, E, Cr	PSO-1,2
CO5	Recall and understand social organization and communication in honey bees and termites. Apply, analyse, and evaluate insect behaviours and chemical signalling. Create diagrams and summaries of insect social and communication systems.	U, R, Ap, An, E, Cr	PSO-2, 4

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

Name of the Course: Entomology 1- 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 and recall core entomological concepts, including classification and economic importance. Apply techniques for insect collection and preservation. Analyse traits for classification, evaluate ecological roles, and create scientific records of specimens.	PO– 1,2 PSO-1,3	U, R, Ap, An, E, Cr	F,	3	1
2.	Recall and understand the structure and function of insect head, thorax, and abdomen. Apply knowledge to identify and compare morphological adaptations. Analyse structural variations and evaluate their ecological significance. Create anatomical diagrams and records of insect features.	PO - 1 PSO-1,3,6	U, R, Ap, An, E, Cr	F,P	3	1
3.	Recall and understand the structure and function of major insect systems. Apply knowledge to identify system components and their roles. Analyze system integration and specialization. Evaluate their adaptive significance. Create diagrams and summaries of insect physiological processes.	PO -1,6 PSO-4,6	U, R, Ap, An, E, Cr	F, P	3	1
4.	Recall and understand insect reproductive systems and hormonal control of metamorphosis, moulting, and diapause. Apply and analyse developmental adaptations. Evaluate endocrine roles and create diagrams illustrating key processes.	PO -1,2 PSO-1,2	U, R, Ap, An, E, Cr	F,C	4	
5.	Recall and understand social organization and communication in honey bees and termites. Apply, analyse, and evaluate insect behaviours and chemical signalling. Create diagrams and summaries of insect social and communication systems.	PO-1,2,4 PSO-2,4	U, R, Ap, An, E, Cr	F,C	4	

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	PO5	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	3 hours	-	2	5
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	45 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**	**8**
	2.1	**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:** Causes of ozone depletion, brief account of the Ozone depletion process. Impacts of ozone depletion on plants and animals including humans. Brief descripition on control measures.	2
	2.3	**Green House Effect and Global Warming:** Concept of Green House Effect and global warming. Mention Greenhouse gases - (Carbon dioxide (CO_2), Methane (CH_4), and Nitrous oxide (N_2O). Impacts of Global Warming.(Brief description only) *(Discussion mode of learning can be adapted).*	3
III		**Pollution-Related Environmental Issues**	**16**
	3.1	**Air Pollution**: Sources of air pollution, Mention indoor air pollution. Brief account on the effects of Air pollution on environment, climate and human health. Pollution Resolution by UN Environment Assembly, 2024 (Brief Account Only). *A quiz can be administered utilising the Mentimeter App for the learning experience.*	3
	3.2	**Environmental Disasters Caused by Air Pollution:** Brief account on 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*	1
	3.3	**Water Pollution:** Causes of degradation of aquatic ecosystems, Brief account of the impact of water pollution on ecosystems including humans. Mention Biological magnification.	2
	3.4	**Environmental Disasters Caused by Water Pollution:** *Exxon Valdez* oil spill 1989 and Gulf War oil spill 1991, Mercury Poisoning at Minamata Bay. *Poster presentation can be adapted for learning, Group activity, Maximum 5 students in a group*.	1
	3.5	**Soil Pollution:** Sources of soil pollution – Agricultural, Industrial, Urban, Effect on humans and ecosystems, Brief mention on soil remediation	2
	3.6	**Radioactive pollution ;** Sources of nuclear radiation, Biological effects of Ionizing and Non-ionizing radiations, Radioactive Fallout, Nuclear Winter Nuclear accidents and their environmental impacts. Brief account of the Three Mile Island Accident 1979, Chernobyl Disaster 1986 and Fukushima Accident 2011. Nuclear waste disposal methods *(Poster presentation by students can be adapted for the learning experience, Group activity, A maximum of 5 students in a group).*	7

IV		**Biodiversity Loss**	**8**
	4.1	**Biodiversity Loss:** Causes- Habitat fragmentation and Habitat degradation, Pollution, ,Overexploitation, Invasive species and their competition with indigenous species, and Climate change (Brief account only) *(Quiz competition can be adapted for mode of learning, Group activity, Maximum 5 students in a quiz team).*	2
	4.2	**Biodiversity Loss and its Impacts on Ecosystems** – Food insecurity, health impacts, loss of medicinal resources, Climate instability Mention Coral Bleaching and Biodiversity Loss in Great Barrier Reef of Australia, 2019 Amazon rainforest wildfires. Mention Conservation strategies for biodiversity Restoration- Exsitu and Insitu methods A brief account on the biodiversity hot spots of India. Brief account on Convention on Biological Diversity (CBD) and CITES *(Poster presentation by students can be adapted for the learning experience, Group activity, Maximum 5 students in a group).*	6
V		**Significant Environmental Challenges on a Global Scale**	**9**
	5.1	**Water Scarcity:**. droughts, and conflicts over water resources. Impact on agriculture, industry, and human health. Economic impacts on society. Brief account on water conservation strategies.	3
	5.2	**Desertification:** Definition. Causes , A brief account of effects (Sand and dust storms, Food insecurity, Increasing poverty). 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*).	2
	5.3	**Eutrophication:** Definition, causes and 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).*	1
	5.4	**Ocean Acidification:** Definition. Cause and impacts on marine organisms and tourism industry. Brief account on UN Ocean Decade Program on Ocean Acidification 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 students in a Quiz Team).*	1

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

		PRACTICUM (30 hrs)	
	1	Conduct Biodiversity Survey in Local Habitat (park, garden/wetland) to record species diversity (birds, insects, amphibians, etc.) using simple sampling methods (quadrats, transects	
	2	Collect water/soil samples from local areas and test for pH, turbidity, moisture content and Electrical Conductivity	
	3	Field observation or lab study of local invasive fauna or flora to assess ecological impact.	
	4	Design a small-scale conservation project or awareness campaign for a local environmental issue and prepare a report/ album based on it.	
	5	Use model systems or simulations to show the bioaccumulation of pesticides in food chain.	
	6	Collect water /soil samples ,observe and identify the microplastics using standard laboratory techniques	

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,C	1, 2, 3, 7
CO4	Analyse the interconnectedness between biodiversity loss and its impacts on ecosystem services and planetary health.	U, Ap, E,C	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,Ap, 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: 3:0:1 (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,C	F, C	L	P
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,C	F, C	L	P
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	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	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
6. Field study reports

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	**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 recollect 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/ Principles of Nutrition**	**9**
	1.1	Definition and classification of nutrition-macronutrients (carbohydrate, protein, lipid and fat) and micronutrients (minerals and vitamins).	4
	1.2	Importance of dietary fibre, Prebiotics, probiotics and water in diet.	2
	1.3	Vitamin and mineral Deficiency diseases -Malnutrition types – Obesity and its types, PEM-Kwashiorkor, Marasmus	3
II		**Nutritional requirements**	**4**
	2.1	Nutritional requirements during pregnancy, infants, toddler, children adolescence, adult and old age.	3
	2.2	Balanced diet and its importance in health management.	1
III		**Health and wellness**	**10**
	3.1	Concept of health and wellness, BMI	2
	3.2	Health benefits of regular physical activity- Types of exercise – aerobic and anaerobic (Brief account).	2
	3.3	Mental and Emotional health- Stress management and resilience	2
	3.4	Relaxation techniques-Deep breathing, Progressive Muscle Relaxation (PMR), Yoga and meditation (Brief account only).	4
IV		**Lifestyle diseases**	**4**
	4.1	Major Lifestyle Diseases- Causes, Prevention- Cardiovascular diseases (CVD), Obesity, Diabetes, Cancer.	3
	4.2	Hypokinetic diseases -Brief description only	1

V		**Food adulterants and preservatives**	**3**
	5.1	Food adulteration- Examples (Milk, Turmeric, Chilli, Honey)	1
	5.2	Common food preservatives – Mention any four examples (Sodium benzoate, Citric acid, Salt, Sugar).	1
	5.3	Junk food and its health implications., Common Hygienic practices for good health.	1

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	Topic
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	Construct a Vitamin Chart showing its sources and deficiency
7	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	Identify and explain the classification and functions of macro- and micronutrients, assess the role of dietary components like fibre, prebiotics, probiotics, and water, recognize deficiency diseases and types of malnutrition including obesity and PEM, and apply the knowledge to evaluate and design balanced dietary plans for health and wellness.	U, R, Ap, An, E, C	PSO-1,3

CO2	Understand nutritional needs at different life stages and the importance of a balanced diet for good health.	U, R, Ap, An, E, C	PSO-1,3
CO3	Explain about health, wellness, exercise types, healthy diet tips, and stress management techniques.	U, R, Ap, An, E, C	PSO-1,2
CO4	Understand hypokinetic diseases and identify the common lifestyle diseases and their causes.	U, R, Ap, An, E, C	PSO-1,2
CO5	Identify common food adulterants and preservatives, understand the health risks of junk food, and apply basic hygienic practices to promote personal and community health.	U, R, Ap, An, E, C	PSO-5,6,7

R-Remember, U-Understand, Ap-Apply, An-Analyze, 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 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**	**P O1**	**PO 2**	**PO 3**	**PO 4**	**P O5**	**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

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 "Chordate Diversity Part II" provides an in-depth exploration of reptiles, birds, mammals, and primates. It covers general characteristics, examples of modern reptiles and their distribution, IUCN status, threats and their conservation. The course supplies some topics to learn about the origin of reptiles and birds, including flightless and flying species. The course also examines egg-laying, pouched, and placental mammals, a section on primates and animals from extreme environments and ends with the merging of the basic facts on classical taxonomy and molecular taxonomy. Through lectures, activities, and field visits, students gain a comprehensive understanding of chordates' diversity and adaptations, highlighting their significance and role in the animal world.				

Detailed Syllabus

Module	Unit	Content	45 Hrs
I		**Reptiles**	**13**
	1.1	**Reptiles:** Key characteristics of reptiles, Briefly Mention the significant evolutionary changes acquired by the ancestral amphibians into terrestrial reptiles mention only Amniotic eggs, dry skin, and thoracic breathing. (Brief account only).	2
	1.2	**Modern Reptiles:** Brief account of the essential characteristics of modern reptiles	

		Turtles and Tortoises: General characters. Mention differences between turtles and tortoises. Examples- **Green sea turtle** (*Chelonia mydas)* and **Indian star tortoise** (*Geochelone elegans*) Mention IUCN status, distribution, salient features, threats and conservation.	2
	1.3	**Tuataras:** General characters.Example **Tuatara** (*Sphenodon punctatus*) Mention IUCN status, distribution, salient features, threats and conservation.	1
	1.4	**Lizards:** General characters.Examples: **Dussumier's forest skink** (*Sphenomorphus dussumieri*) and **Oriental garden lizard** (*Calotes versicolor*). Mention IUCN status, ecology, and salient features **Snakes-Venomous Snakes:** General characters.**Examples: Indian cobra** (*Naja Naja*)**, Banded krait** (*Bungarus fasciatus*), *and* **Malabar pit viper** (*Craspedocephalus malabaricus*) Mention IUCN status, distribution, salient features, threats, conservation and nature of venom . **Nonvenomous Snakes:** General characters. Examples: **Keeled rat snake** (*Ptyas carinata*), the **Indian python** (*Python molurus*), and the **Wolf snake** (*Lycodon aulicus*) Mention IUCN status, distribution, salient features, threats, and conservation.	6
	1.5	**Crocodiles and Alligators:** General characters, Examples: **Fish-eating crocodile** (*Gavialis gangeticus*) and **American alligator** (*Alligator mississippiensis*) Mention IUCN status, distribution, salient features, threats and conservation. Difference between Crocodiles and Alligators.	2
II		**Birds**	**7**
	2.1	**Birds:** Key characteristics (Different types of feathers and flight skeleton), Briefly mention the changes acquired by ancestral reptiles for avian mode of life. Brief account of characteristics of modern birds mention only Efficient respiration, Efficient circulation, and Endothermy.	2
	2.2	**Flightless Birds:** General characters. Examples:**Common ostrich** (*Struthio camelus*) - Mention breathing adaptation and predators, **Common kiwi** (*Apteryx australis*) and **King penguin** (*Aptenodytes patagonicus*) Mention IUCN status, distribution, salient features and threats.	2
	2.3	**Flying birds:** General characters.,Examples **Rock pigeon** (*Columba livia*), **Indian Cuckoo** (*Cuculus micropterus*) - Mention brood parasite behaviour, **Great Pied Hornbill** (*Buceros bicornis)*, Mention IUCN status, distribution, salient features, threats, and conservation . Adaptations for flight in modern birds.	3
III		**Mammals**	**9**
	3.1	**Mammals:** Fundamental characteristics (Hair and Mammary glands) and notable features (Endothermy and Placenta).	2
	3.2	**Modern mammals - Egg-laying mammals (Monotremes):**	2

		General characters, Examples: **Short-beaked echidna** (*Tachyglossus aculeatus*) and **Duck-billed platypus** (*Ornithorhynchus anatinus*). Retention of reptilian characters.Mention IUCN status, distribution, salient features, threats, and conservation.	
	3.3	**Modern mammals- Pouched mammals (Marsupials):** General characters. Mention briefly about the origin and pattern of embryonic development. Examples:**Red Kangaroo** (*Macropus rufus*) and **Koala** (*Phascolarctos cinereus*).Mention IUCN status, distribution, salient features, threats, and conservation.	2
	3.4	**Modern mammals- Placental Mammals:** General characters. Mention the speciality of the placenta. Examples; **Asian elephant** (*Elephas maximus*) and **Ganges river dolphin** (*Platanista gangetica*) Mention IUCN status, distribution, salient features.	3
IV		**Living Primates**	**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. Examples: R**ing-tailed lemur** (*Lemur catta*). **Lorises:** General features. A short account of the **Pygmy slow loris** (*Xanthonycticebus pygmaeus*). **Tarsiers:** General features. A brief account of the Philippine **tarsier** (*Carlito syrichta*).	3
	4.3	**Monkeys:** General features.Examples:A brief account of **Lion-tailed macaque** (*Macaca silenus)*. **Ape:** General features. A short account of **Chimpanzee** (*Pan troglodytes*), **Gorilla** (*Gorilla gorilla*). **Hominids (Humans and their direct ancestors):** General features. Brief account of Humans (*Homo sapiens*).	3
V		**Reptiles, Birds and Mammals in the Extreme Environments**	**9**
	5.1	**Extreme Environments:** Brief account of the Extreme habitats (Cold climate and Hot climate) Mention adaptations of the organisms mentioned below. **Cold climate (Ice):** Brief account of **Emperor penguin** (*Aptenodytes forsteri*), **Snow Leopard** (*Panthera uncia*), and **Polar Bear** (*Ursus maritimus*). **Hot climate (Desert):** Brief account of **Dromedary Camel** (*Camelus dromedarius*), **Gila monster** (*Heloderma suspectum)* and **Giant kangaroo rat** (*Dipodomys ingens*).	4
	5.2	**Bridging the concepts of Classical taxonomy and Molecular taxonomy**	

		Classical taxonomy (Traditional taxonomy) Mention definition and approaches (morphological, anatomical, embryological and ecological) Raven et al. (2017) Molecular Taxonomy (Phylogenetics) Mention definition and approaches .Concepts in cladistics. The concept of phylogeny of Clade Sauropsida (Brief account only). Mention the position of birds in a cladistic sense. Mention the position of Mammals in a cladistic sense.	5

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. Michael J. Benton (2024).Vertebrate Palaeontology, 5th edition, Wiley.
4. Parker & Haswell A. (2005). Text Book of Zoology Vol.II, Macmillan.
5. 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.
4. Daniel J.C. (2002). The Book of Indian Reptiles and Amphibians. Bombay Natural History Society.
5. Vivek Menon (2023). Indian Mammals. Hachette India.
6. Scott Weidensaul (2022). A World on the Wing. Picador-The Smithson, London.

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.)

(From Sl.No.1 to 11, **4 & 5** compulsory and out of nine **any five** can be selected for record preparation and **any two** items to be done from Sl. No.12 to Sl.No.18)

Sl. No.	Content
1	Turtles & Tortoises - Olive ridley sea turtle (*Lepidochelys olivacea*), and Travancore tortoise (*Indotestudo travancorica*): Spotter, Salient features (Use photos/drawings).
2	Reptiles - Common chameleon (*Chamaeleo chamaeleon*), 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	Study structure of carapace and plastron: Using original or models, Draw and label.
5	Study the different types of feathers and identification - Quill feather, Contour feather, Filoplume, Down feathers. (Identify ,Draw and label) (Practical- Major)
6	Flightless Birds - Common kiwi (*Apteryx australis*) and Emu (*Dromaius novaehollandiae*): Spotters, Salient features (Use photos/drawings).
7	Flying Birds - Common swift (*Apus apus*), Common tea peregrine falcon (*Falco peregrinus*) and Bar-headed goose (*Anser indicus*): Spotters, Salient features (Use photos/drawings).
8	Egg-laying mammals (Monotremes): Western long-beaked echidna (*Zaglossus bruijnii*) and Duck-billed platypus (*Ornithorhynchus anatinus*): Spotters, Salient features (Use photos/drawings).
9	Pouched mammals (Marsupials): Tasmanian devil (*Sarcophilus harrisii*) and Musky rat-kangaroo (*Hypsiprymnodon moschatus*): Spotters, Salient features (Use photos/drawings).
10	Placental Mammals: African bush elephant (*Loxodonta africana*) and Dugong (*Dugong dugon*): Spotters, Salient features (Use photos/drawings).
11	Compare and differentiate primates from non-primates based on external morphological characteristics using photographs or images.(Human, monkey, gorilla, chimpanzee, lemur& Dog, cat, horse, squirrel, elephant, bat)
12	Construct a flowchart on the relationship of the tuatara to other living reptiles and birds (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.

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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	Acquire competency in identifying, describing,comparing and analysing the general characteristics of modern reptiles (Turtles, snakes, crocodiles etc) and their uniqueness, threats and conservation .	U, R,Ap,An,E, C	1, 2, 3
CO-2	Obtain proficiency in familiarising, distinguishing, and analysing the key characteristics of different birds(flightless birds and flying birds with some common birds as examples) and the evolutionary changes.	R, U, Ap,An, E,C	1, 2 3, 4

CO-3	Gain expertise in differentiating, analysing and comparing the fundamental characteristics and basic facts about mammals (modern mammals egg laying, pouched and placental mammals) .	R, U, Ap,An, E,C	1, 2, 4
CO4	Obtain skill in Explain, differentiate and analyse the basic facts about Living primates(Lemurs, Tarsiers and Monkeys etc).	R, U, Ap,An, E,C	1, 2, 3, 4, 7
CO5	Develop excellence in the basic concepts of extreme environments and animals in the habitat and how they adapted (Ice and desert environment) as well as attain competency in classical and modern concepts in taxonomy (position of reptiles, birds and mammals in cladistic taxonomy)	R, U, Ap, An, E,C	1,2,3,7

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

Note: 1 or 2 COs/module

Name of the Course: Chordates 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	Acquire competency in identifying, describing,comparing and analysing the general characteristics of modern reptiles (Turtles, snakes, crocodiles etc) and their uniqueness, threats and conservation .	PO-1,2 PSO-1, 2, 3	U, R,Ap,An,E,C	F, C,P,M	L/T	p
CO-2	Obtain proficiency in familiarising, distinguishing, and analysing the key characteristics of different birds(flightless birds and flying birds with some common birds as examples) and the evolutionary changes.	PO-1, 2, 3/ PSO-1, 2, 3,	U, R,Ap,An,E,C	F, C,P,M	L/T	P
CO-3	Gain expertise in differentiating, analysing and comparing the fundamental characteristics and basic facts about mammals (	PO- 1, 2, 5/ PSO-1, 2, 3	U, R,Ap,An,E,C	F, C,P,M	L/T	P

	modern mammals egg laying, pouched and placental mammals) .					
CO-4	Obtain skill in Explain, differentiate and analyse the basic facts about Living primates(Lemurs, Tarsiers and Monkeys etc).	PO-1, 2, 3, 5/ PSO-1, 2, 3, 4,	U, R,Ap,An,E,C	F, C,P,M	L/T	P
CO-5	Develop excellence in the basic concepts of extreme environments and animals in the habitat and how they adapted (Ice and desert environment) as well as attain competency in classical and modern concepts in taxonomy (position of reptiles, birds and mammals in cladistic taxonomy)	PO-3, 5, 6/ PSO-1, 2, 3	U, R,Ap,An,E,C	F, C,P,M	L/T	P

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

Mapping of COs with PSOs and POs :

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

Correlation Levels:

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

Assessment Rubrics:

Assignment/in class discussion, seminar

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**		**8**
	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 *Industrial Melanism*.	2
	1.3	Speciation- Sympatric and Allopatric; Isolation and isolating mechanisms.	3
	1.4	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).	3
	2.3	Genetic basis of evolution- gene pool, gene frequency, genetic drift, genetic equilibrium; factors affecting genetic equilibrium and Hardy – Weinberg law.	3
III	**Human Evolution**		**9**
	3.1	Evolution of Man- Brief account – Hominid fossils.	5

	3.2	Molecular Basis of Evolution; Contributions of Svante Paabo (Paleogenomics, Paleoanthropology).	4
Zoogeography			**13**
IV	4.1	Introduction to Zoogeography and patterns of animal distribution- cosmopolitan, dis-continuous, bipolar and isolated distribution, factors affecting animal distribution.	3
	4.2	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.	5
	4.3	Bio-geographical classification of Indian Sub-continent- Biodiversity hotspots in India -Western Ghats, Eastern Ghats and Himalayas. Insular Fauna: Brief account of oceanic islands (Galapagos) and continental islands (British Isles). Plate tectonics and Continental Drift theory (Brief account).	5
V	**Phylogeny, Evolutionary and Extinction Events**		**7**
	5.1	Phylogenetic Tree -Distance and Parsimony methods. Origin of new genes and proteins, Migration and Random Genetic Drift, Convergent Evolution- Sexual selection and gene pool mixing.	3
	5.2	Barriers and means of dispersal (Land and Aquatic ecosystems).	2
	5.3	Evolution of Gene families- Molecular Drive.	1
	5.4	Extinction - Background and mass Extinctions (causes and effects) and K-T Extinction.	1

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	Topic
1	Macro evolution using Darwin Finches (Pictures)
2	Photo of Darwin, Lamark, Wallace, Svante Paabo and , Lynn Margulis - 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 major theories of organic evolution, analyze mechanisms like natural selection, speciation, and isolation, and evaluate evolutionary patterns such as adaptive radiation and co-evolution.	R, U, Ap, An, E, C	PSO-1,2
CO-2	Remember the geological time scale and fossil evidence, analyze the genetic basis of evolution including mutation and genetic drift, and evaluate concepts like Hardy-Weinberg law and neo-Darwinism.	R, U, Ap, E, An, C	PSO-1,2
CO3	Understand the evolution of man through hominid fossils and analyse the molecular basis of evolution with insights from Svante Paabo's contributions to paleogenomics and paleoanthropology concepts of evolution	R, U, Ap, E, An, C	PSO-1,2
CO 4	Remember major zoogeographical branches, understand patterns and factors of animal distribution, analyze biogeographical realms and Indian biodiversity zones, and evaluate the impact of continental drift on faunal distribution.	R, U, Ap, E, An, C	PSO-1,2
CO5	Understand evolutionary processes and extinction events, analyze gene evolution and dispersal mechanisms, and evaluate patterns like genetic drift, sexual selection, and mass extinctions.	R, U, Ap, E, An, C	PSO-1,3

R-Remember, U-Understand, Ap-Apply, An-Analyze, 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**	**PS O5**	**PS O6**	**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

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	Assignmen t	Project Evaluation	End Semester Examination
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	Class 12 Pass				
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: Comparative Anatomy of Vertebrates

Theory [4 Credits; 60 Hours]

Module	Unit	Content	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 Activities: 1. *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 there are 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 Activities*:* 1. *Group Discussion – Is nervous system the most important system which make 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
4. Karel, F. Liem and Warren, F. Walker (2001). Functional Anatomy of the Vertebrates: An Evolutionary Perspective. Harcourt College Publishers, Fort Worth. https://archive.org/details/functionalanatom0000unse_j8q8
5. George C. Kent and Robert Carr (2001) Comparative Anatomy of Vertebrates (9th Ed.). McGraw Hill Publications, New York.
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
7. Saxena, R.K. and Sumitra Saxena (2015). Comparative Anatomy of the Vertebrates. MV Learning.
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 and understand the principles, importance, and evolutionary context of comparative anatomy. Apply these concepts to study vertebrate morphology. Analyse phylogenetic relationships using anatomical evidence. Evaluate the relevance of comparative anatomy in biology. Create comparative charts and concept maps of vertebrate structural features.	**R, U, Ap, An, E, C**	PSO-1
CO-2	Identify and understand the evolution, structure, and function of vertebrate axial and appendicular skeletons. Apply anatomical knowledge to distinguish skeletal	**R, U, Ap, An, E, C**	PSO-3

	adaptations. Analyse bone structure across vertebrate groups. Evaluate functional modifications for various habitats. Create labelled diagrams and comparative tables of skeletal systems.		
CO-3	Recall and understand vertebrate muscle types and their roles in locomotion. Apply functional anatomy to explain muscle mechanics. Analyse muscular adaptations in diverse vertebrates. Evaluate biomechanical efficiency across species. Create annotated illustrations and summaries of muscular systems.	**R, U, Ap, An, E, C**	PSO-1, PSO-3
CO-4	Recall and understand the diversity of vertebrate circulatory and respiratory systems. Apply comparative approaches to identify structural and functional adaptations. Analyse heart, vessels, lungs, gills, and other organs across taxa. Evaluate efficiency in gas exchange and blood circulation. Create visual models and flowcharts of circulatory and respiratory pathways.	**R, U, Ap, An, E, C**	PSO-3, PSO-4
CO-5	Recall and understand structural and functional aspects of vertebrate digestive and nervous systems. Apply comparative anatomy to recognize system adaptations. Analyse variations in brain, nerves, and digestive organs among groups. Evaluate evolutionary trends in complexity and efficiency. Create comparative diagrams and reports on functional anatomy.	**R, U, Ap, An, E, C**	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 and understand the principles, importance, and evolutionary context of comparative anatomy. Apply these concepts to study vertebrate morphology. Analyse phylogenetic relationships using anatomical evidence. Evaluate the relevance of comparative anatomy in biology. Create	PO1/ PSO-1	**R, U, Ap, An, E, C**	**F, C**	**L**	-

	comparative charts and concept maps of vertebrate structural features.					
2.	Identify and understand the evolution, structure, and function of vertebrate axial and appendicular skeletons. Apply anatomical knowledge to distinguish skeletal adaptations. Analyse bone structure across vertebrate groups. Evaluate functional modifications for various habitats. Create labelled diagrams and comparative tables of skeletal systems.	PO1,PO 3,PO4,P O6,PO7, PO8/ PSO-3	**R, U, Ap, An, E, C**	**F, C, P**	**L**	-
3.	Recall and understand vertebrate muscle types and their roles in locomotion. Apply functional anatomy to explain muscle mechanics. Analyse muscular adaptations in diverse vertebrates. Evaluate biomechanical efficiency across species. Create annotated illustrations and summaries of muscular systems.	PO1,PO 3,PO4,P O6,PO7, PO8/ PSO-1, PSO-3	**R, U, Ap, An, E, C**	**P**	**L**	-
4.	Recall and understand the diversity of vertebrate circulatory and respiratory systems. Apply comparative approaches to identify structural and functional adaptations. Analyse heart, vessels, lungs, gills, and other organs across taxa. Evaluate efficiency in gas exchange and blood circulation. Create visual models and flowcharts of circulatory and respiratory pathways.	PO1,PO 3,PO4,P O6,PO7, PO8/ PSO-3, PSO-4	**R, U, Ap, An, E, C**	**C, P**	**L**	-
5.	Recall and understand structural and functional aspects of vertebrate digestive and nervous systems. Apply comparative anatomy to recognize system	PO7, PO8/ PSO-4	**R, U, Ap, An, E, C**	**P**	**L**	-

	adaptations. Analyse variations in brain, nerves, and digestive organs among groups. Evaluate evolutionary trends in complexity and efficiency. Create comparative diagrams and reports on functional anatomy.					

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	3 hours	-	2	5
Pre-requisites	Pass in Class XII				
Course Summary	This course will provide the basics and history of aquaculture to the students. A wide range of aspects of aquaculture like aquaculture practices, design and construction of 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	45Hrs
I		**Introduction to Aquaculture**	**10**
	1.1	Present status and Scope of aquaculture in India and Kerala, Consumption scenario and Emerging trends in Aquaculture.	3
	1.2	Criteria for the selection of sites (nutrient and soil quality, water supply and water circulation, water quality, Environment Impact Assessment) for various aquaculture practices, (Freshwater, Brackishwater and Marine Water)	3
	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.	3

	2.3	Types of culture systems - Monoculture, polyculture, Sewage fed Farming, Integrated culture systems, Recirculated aquaculture Systems (RAS) Related activity - Visit any one aquaculture system and submit a report	2
III	**Design and construction of farm and hatchery**		**7**
	3.1	Size, shape, lay out of pond farms, dike design and construction, water supply and drainage system.	2
	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, Stocking and Management**		**15**
	4.1	Pre-stocking Pond management – sun drying, repairing, desiltation, ploughing, liming, eradication of predators and weeds, water filling, fertilization. Importance of bloom	3
	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	2
	4.4	Feed management – Types of feed, formulated feed, feeding rate, feed conversion ratio, feed additives, binders, microencapsulated feeds, nutraceuticals, brooder diet and Live Feed. (Brief accounts only)	2
	4.5	Monitoring physical and chemical parameters of water, Rate and time of water exchange.	2
	4.6	Monitoring health of stock , regular sampling and disease management.	2
V	**Harvesting and sustainability**		**5**
	5.1	Harvesting of drainable and undrainable ponds, cages, molluscan farms. Handling and preservation.	2
	5.2	Sustainability and environmental management	3

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.
5. Beets WC. 1990. Raising and Sustaining Productivity of Small- Holder Farming Systems in the Tropics. Agbe Publ.
6. Bose AN. 1991. Coastal Aquaculture Engineering. Oxford and IBH Publ.
7. Bregnballe J. 2015. A Guide to Recirculation Aquaculture. FAO Publ.
8. Burnell G, Allan G. 2009. New Technologies in Aquaculture. 1st Edition. Woodhead Publishing House.
9. Boyd, C. E. and Tucker, C. S. 1992. Water Quality and Pond Soil Analyses for Aquaculture, Alabama Agricultural Experimental Station, Auburn University
10. Creed R. 2017. Aquaculture and Fish Farming. Syrawood Publ
11. Davion A. 2018. Recirculating Aquaculture Systems: a Guide to Farm Design and Operations.

12. Edwards P, Little DC and Demaine H. (Eds.). 2002. Rural Aquaculture. CABI.
13. FAO 2001. Planning and Management for Sustainable Coastal Aquaculture Development. FAO.
14. ICAR. 2006. Handbook of Fisheries and Aquaculture. ICAR
15. Imai T. 1978. Aquaculture in Shallow Seas. Progress in ShallowSea Culture. Amerind Publ.
16. Ivar LO. 2007. Aquaculture Engineering. Daya Publ. House.
17. James PM. 1983. Handbook of Mariculture. Vol. I. Crustacean Aquaculture. CRC Press.
18. Jhingran VG and Pullin RSV. 1985. Hatchery Manual for the Common, Chinese and Indian Major Carps. ICLARM, Philippines.
19. John. S. Lucas and Paul. C. Southgate (Eds.) 2012. Aquaculture – Farming Aquatic Animals and Plants. Blackwell Publishing.
20. Lekang O, I. 2013. Aquaculture Engineering. Wiley-Blackwell Publ.
21. Leung P, Lee CS and O'Bryen JP. (Eds.). 2007. Species and System Selection for Sustainable Aquaculture. Blackwell Publ.
22. Midlen and Redding TA. 1998. Environmental Management for Aquaculture. Chapman and Hall.
23. Muthu MS. 1983. Culture of Live Feed Organisms. Tech. Paper 14. Summer Institute in Hatchery Production of Prawns Seeds. CMFRI, Cochin.
24. Pillay TVR and Kutty MN. 2005. Aquaculture- Principles and Practices. Blackwell.
25. Sharma LL, Sharma SK, Saini VP and Sharma BK. (Eds.). 2008. Management of Freshwater Ecosystems. Agrotech Publ. Academy.
26. Selvamani BR and Mahadevan RK. 2008. Aquaculture, Trends and Issues. Campus Books International. FAO, 2011. Code of conduct for responsible fisheries. FAO special edition
27.Thomas L. 1995. Fundamentals of Aquacultural Engineering. Chapman and Hall
28.Tidwell JH. (Ed.). 2012. Aquaculture Production Systems. Wiley-Blackwell.
29.Timmons MB, Guerdat, T, Vinci, BJ. 2019. Recirculating Aquaculture. Ithaca Publishing Comp.
30.Yoram, A., 2015. Biofloc Technology: a Practical Guidebook. WAS Publ

Practicum Component (Credit :1 , 30 Hrs)

Practicum		
Sl. No	**Content**	**30 Hrs**
1.	Determination of soil texture using soil trigon method/field method (Major)	3
2.	Determination of pH in soil and water samples (Minor)	2
3.	Calculation of lime requirement for brackish water pond (Minor)	3
4.	Determination of primary productivity (Light and dark bottle method) (Major)	3
5.	Estimation of salinity in water sample using titration and refractometer (Major)	3
6.	Determine transparency of pond water using Secchi Disc (Minor)	2
7.	Fish feed formulation (Square method) and preparation (Major)	5
8.	Collection and identification of aquatic weeds, insects, weed fish and predatory fish (any two in each category) (Minor)	6
9.	Identification of live feeds – Paramecium, Rotifer, Daphnia, Moina, Artemia, Copepod (Any three) (Minor)	3

References:

1. Kungvankij P. and T.E. Chua. 1986. Shrimp Culture, Pond Design, Operation and MAnagement. NACA Training Manual Series. 2. FAO, NACA and RLCP.
2. Elvira A. Baluyut. 1989. Aquaculture Systems and Practices: A Selected Review. UNDP, FAO.
3. Judith Betsy. C and S. Felix. 2019. Principles of Aquaculture: Practical Manual. Narendra Publishing House.
4. Rather, M. 2024. Technical Guide to Carp Culture. Narendra Publishing House.

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Understand the scope of aquaculture, status of aquaculture in India and Kerala and criteria for selection of sites and species for culture and commercially important common cultivable species	U, R, An	1,3
CO-2	Understand different types and systems of aquaculture and different types of aquaculture practices.	U, R, An,C	2,5
CO-3	Acquire knowledge in design and construction of culture systems and hatcheries	R, U, An,C	4,5
CO-4	To get familiarised with pre-stocking pond management, seed resources , seed stocking , feed management and monitoring parameters and health of stock	AP, An, E,C	4,5
CO-5	To get an awareness on post stocking management practices for a profitable culture.	U, Ap,An,C	4,5,7

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

Name of the Course: 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 scope of aquaculture, status of aquaculture in India and Kerala and criteria for selection of sites and species for culture and commercially important	PO2,3,7/ PSO4,5	U, R, An	C, P, M	L	

	common cultivable species					
2	Understand different types and systems of aquaculture and different types of aquaculture practices.	PO2,3,7/ PSO4,5	U, R, An,C	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	C, P, M	L	
4	To get familiarised with pre-stocking pond management, seed resources , seed stocking , feed management and monitoring parameters and health of stock	PO2,3,7/ PSO4,5	Ap, An, E,C	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, Ap,An,C	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

Field activities

1. Visit to aquaculture farms & submission of report on cultivable species
2. Make a report on any systems of aquaculture by visiting the culture areas and submit the report

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 biology of honey bees (*Brief*), Honey bee species occurring in India, Morphological characters for identification of different bee species.	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.	3
		Related Activities: 1. Group Discussion – "*A world without honey bees*" 2. Set-up a bee hive in college campus (if possible)/ or visit a bee farm	
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.	5
		Related Activities: 1. Debate – "Natural Silk vs Synthetic Silk" 2. Visit a Sericulture institute	
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	3
		Related Activities: 1. Collect and display different Lac Products (Group Activity)	

IV	**Methods of pest management in residential places and public buildings**		**8**
	4.1	Common insect Pests – House-hold general Pests - termites, ants, bed bugs, cockroaches, aphids, and mites *(Brief description)*; Agricultural pests - thrips, fall armyworm, and *Sesamia inferens(Brief description)*; Stored grain pests - Rice weevils, Angoumois grain moths, and Indian meal moths *(Brief description)*	3
	4.2	Insecticides for domestic use and their safety, Pre and post construction termite proofing of buildings, Appliances for domestic pest control; Organic methods of domestic pest management.	5
		Related Activities: 1. Collect 5 pest species and display 2. Discussion on Chemical Insecticides, Hazards and Safety Precautions	
V	**Insect pests in human habitation**		**8**
	5.1	Public health risk of insect pests in human habitation.	3
	5.2	Biology, damage caused and control of mosquitoes, houseflies, bed bugs, ants, termites and cockroaches.	5
		Related Activities: 1. Debate – "Complete Eradication of Pest species. Good or Bad?"	

References

1. Aruga H. 1994. Principles of Sericulture. Oxford & IBH, New Delhi.
2. Atwal AS. 2006. The World of the Honey Bee. Kalyani Publ., New Delhi.
3. Ganga G. 2003. Comprehensive Sericulture. Vol. II. Silkworm Rearing and Silk Reeling. Oxford & IBH, New Delhi.
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 and identify Indian honey bee species. Apply seasonal colony management and equipment use. Analyse bee behaviour and productivity. Evaluate disease control methods. Create beekeeping setups and discuss ecological roles.	R, U, Ap, An, E, C	PSO-1,2
CO-2	Understand silkworm biology and host plants. Apply rearing and disease control methods. Analyse silk types and species. Evaluate sericulture techniques. Create silk models and engage in debates on natural vs. synthetic silk.	R, U, Ap, An, E, C	PSO-1,2
CO3	Understand lac insect biology and strains. Apply cultivation and processing methods. Analyse product formation and usage. Evaluate lac's industrial value. Create product displays and presentations on lac applications.	R, U, Ap, An, E, C	PSO-1,2
CO4	Understand key residential, agricultural, and storage pests. Apply control strategies using safe methods. Analyse infestation patterns. Evaluate pest control tools and practices. Create charts or models for pest identification and control.	R, U, Ap, An, E, C	PSO-1,2
CO5	Understand domestic pest biology and health impacts. Apply control strategies for key pests. Analyse life cycles and disease links. Evaluate eradication practices. Create awareness materials for pest prevention.	R, U, Ap, An, E, C	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 and identify Indian honey bee species. Apply seasonal colony management and equipment use. Analyse bee behaviour and productivity. Evaluate disease control methods. Create beekeeping setups and discuss ecological roles.	PO 1, PO2/ PSO-1,2	R, U, Ap, An, E, C	F, C	L	
2.	Understand silkworm biology and host plants. Apply rearing and disease control methods. Analyse silk types and species. Evaluate sericulture techniques. Create silk models and engage in debates on natural vs. synthetic silk.	PO 1, PO 2/ PSO-1,2	R, U, Ap, An, E, C	F, C	L	
3.	Understand lac insect biology and strains. Apply cultivation and processing methods. Analyse product formation and usage. Evaluate lac's industrial value. Create product displays and presentations on lac applications.	PO 3/ PSO-1,2	R, U, Ap, An, E, C	P	L	
4.	Understand key residential, agricultural, and storage pests. Apply control strategies using safe methods. Analyse infestation patterns. Evaluate pest control tools and practices. Create charts or models for pest identification and control.	PO 3/ PSO-1,2	R, U, Ap, An, E, C	C. P	L	

5.	Understand domestic pest biology and health impacts. Apply control strategies for key pests. Analyse life cycles and disease links. Evaluate eradication practices. Create awareness materials for pest prevention.	PO 1,2,6/PSO – 2,5	R, U, Ap, An, E, C	C,P	L	

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

Mapping of Cos with PSOs and Pos:

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO 7	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CO1	1	2	-	-	-	-	-	2	2	-	-	-	-	-	-
CO2	2	3	-	-	-	-	-	3	1	-	-	-	-	-	-
CO3	1	2	-	-	-	-	-	-	-	2	-	-	-	-	-
CO4	2	1	-	-	-	-	-	-	-	3	-	-	-	-	-
CO5	-	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	3	2	-	5
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	45 Hrs
I	**Air Pollution: Causes and Impacts**		**9**

	1.1	Air Pollution: Point and non-point sources, Primary and secondary air pollutants. Weather parameters influencing air pollution (Dispersion,wind, temperature inversion, Heat Island effect and Wind valley effect)	1
	1.2	Effects of air pollution on plants and animals including humans. Mention the impacts of acid rain and photochemical smog	2
	1.3	Role of air pollution in climate change (Green House Effect, Global Warming, Ozone Depletion- Brief description only) **Related activity**: *A quiz can be administered utilising the Mentimeter App for the learning experience*	2
	1.4	Case studies on air pollution, threats and challenges. Examples: Bhopal Gas Tragedy (1984),The Beijing Smog Crisis (2013) and The Delhi Air Pollution Crisis (ongoing), Endosulphan Tragedy in Kerala **Related activity**: *Poster presentation can be adapted for learning. Group activity, Maximum 5 students in a group*.	2
	1.5	Air pollution abatement technologies (Design and working of Bag filters, scrubbers, electrostatic precipitators, catalytic converters). Use of Remote Sensing and GIS in Air Pollution – Brief account only Concept of Carbon footprint, carbon credits and carbon trading in regulating emissions.	2
II	**Water Pollution: Causes and Impacts**		**10**
	2.1	Natural and anthropogenic sources, Major Pollutants (Organic and inorganic pollutants, Pathogens, nutrients (N, P), heavy metals, pesticides, plastics)	2
	2.2	Impact of Water Pollution (Impact on Aquatic Ecosystems-Eutrophication, bioaccumulation, biodiversity loss) Impact on Human Health (Waterborne diseases, contamination of drinking water-Mention Methemoglobinemia)	2
	2.3	Water Quality Parameters and Indicators (Physical, chemical, biological parameters (BOD, COD, TDS, pH, DO, coliforms) National and international water quality standards (e.g., WHO, EPA, BIS) Legal aspects and policies (Brief description only)	2
	2.4	Pollution Control and Management-Treatment Technologies (Mention Primary, secondary, and tertiary treatment of wastewater – Design and operations of Screens, Frit chambers, Sedimentation tanks and Oxidation ponds. Design and operations of biological treatment systems -Aerated lagoons, Activated sludge process, Trickling filters and Sludge digestion.	2

		Emerging technologies in water treatment (Membrane filtration, Bioremediation) Pollution Prevention and Sustainable Practices (Source control, public awareness, water conservation techniques Namami Gange programme- Brief description only **Related activity**: *Power point competition can be adapted for mode of learning, Group activity, Maximum 5 students in a team*.	
	2.5	Case studies on water pollution, threats and challenges. The Love Canal Disaster (1978) and The Flint Water Crisis (2014-2019). Yamuna River pollution , Delhi and Periyar river Pollution, Kerala **Related activity**: *PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group*	2
III	**Land Pollution: Causes and Impacts**		**9**
	3.1	Sources of land pollution- Urbanization, Industrialization, Agricultural activities, improper disposal of solid waste and hazardous waste, mining, deforestation, E-waste, Plastics – Brief account only	1
	3.2	Pathways of soil contamination: direct release, atmospheric deposition, leaching and runoff. Introduction to soil quality indicators and standards for assessing for assessing contamination levels	2
	3.3	Overview of key pollutants: heavy metals, pesticides, petroleum hydrocarbons, and persistent organic pollutants (POPs), Solid wastes ,Radioactive contaminants	2
	3.4	Effect of soil pollution: on ecosystem (disruption of soil microbial communities, loss of biodiversity, and habitat degradation.) and humans . Biological effects of ionizing radiations and non-ionizing radiations	2
	3.5	Disposal Strategies of control of solid waste pollution Nuclear waste disposal- Near Surface Disposal, Deep Geologic Disposal and space disposal	1
	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, .Fukushima Nuclear Disaster,2011. Pollution abatement and treatment-Mention 3 R's- Reduce Reuse-Recycle Indore model of Waste treatment (Brief account only) Brief description of Cradle to Cradle (C2 C concept)	1

		Related activity: *PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group*.	
IV		**Noise Pollution: Causes and Impacts**	**9**
	4.1	Noise pollution: Definition , Sources (Environmental, Occupational, and Transportation noise.)	2
	4.2	Measure and assess of noise levels: Decibel scale, sound monitoring equipments and noise mapping techniques. Noise Pollution Standards and Legal Framework -WHO guidelines, National standards (e.g., CPCB in India).	3
	4.3	The impact of noise pollution on animals including human (Discussion mode of learning can be adapted). Mention control and management of Noise pollution **Related activity**: *PowerPoint presentation can be adapted for learning experience, Group activity, Maximum 5 students in a group*.	2
	4.4	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**	**8**
	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.	1
	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	1
	5.3	Artificial light at night (ALAN) Effects on wildlife including nocturnal species (behavioural changes, disruption of circadian rhythms, predation risk, and habitat fragmentation)	2
	5.4	The health effects of light pollution on humans (include sleep disturbances, hormonal imbalances, and increased risk of chronic	2

		diseases).	
	5.5	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 and birds(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*	2

References:

1. Boubel R.W., D.L. Fox, and A.C. Stern 1994. Fundamentals of Air pollution. Academic Press, NY,. Company Ltd.
3. Cunniff P.E., 1987. Environmental Noise Pollution. McGraw Hill, New York,.
4. De Nevers N 2000. Air Pollution Control Engineering, 2nd Edition. McGraw Hill, Singapore.
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.
9. Kudesia, V.P and Ritu Kudesia (1992). Water Pollution, Pragati Prakashan Publication, Meerut.
10. Kumarasawmy, K., A. Alagappa Moses and M. Vasanthy (2004). Environmental Studies. Bharathidasan University Publications.
11. Malcom Cresser 1993. Soil Chemistry and its Application. Cambridge University Press.
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.
16. Rao C.S.1993. Environmental Pollution Control, Wiley Eastern Ltd.
17. Rao, M.N and H.V.N. Rao (1993). Air Pollution. Tata McGraw–Hill Publishing Company Limited. New Delhi.
18. Sawyer, C.N., P.L McCarty and G.F. Perkin (1994). Chemistry for Environmental Engineers, II Edition. McGraw-Hill.
19. Sharma, B.K and H. Kaur (1994). Soil and Noise Pollution. Goel Publishing House, Meerut.
20. Stanly Manahan 2011. Environmental Chemistry. CRC Press.
21. Tiwary A, Williams I, Colls J. (2019). Air Pollution: Measurement, Modelling and Mitigation. Fourth Edition.
22. Trivedi P.R. 1992. Environmental Agricultural pollution. Akashdeep Publishing House.

15.https://www.britannica.com/event/Fukushima-accident

	PRACTICUM (Credit :1 30 hrs)		
	1	Estimation of oxygen in the water sample	
	2	Estimation of carbondioxide in the water sample	
	3	Measurement of pH of different water samples using pH meter, pH paper and indicator solution	
	4	Analyze the Primary productivity using dark and light bottle	
	5	Determine the Turbidity using Secchi disc	
	6	Estimation of Biochemical Oxygen Demand (BOD) in water samples.	
	7	Effect of soil pollution on the population of earth worms	
	8	Study of indicator organisms	
	9	Effect of pollution on the oxygen consumption of fishes	
	10	Collect soil samples from different areas (industrial, agricultural, residential) and test for heavy metals, pH, and organic pollutants- any one	
	11	Conduct a solid waste Audit in the campus / community	
	12	Calculate personal or institutional carbon footprints using available tools or spreadsheets	
	13	Studying the effect of polluted water on aquatic organisms like Daphnia or fish fry. Observing mortality or behavioral changes to assess toxicity	
	14	Create microcosms to demonstrate nutrient enrichment and its effects on aquatic ecosystems	
	15	Prepare a Report on noise pollution impact and mitigation in your area	
	16	Visit a local pollution control facility, landfill, or water treatment plant and prepare a report detailing the technologies and management practices observed	
	17	Propose a plan to reduce light pollution in your campus or locality	

Course Outcomes

No.	Upon completion of the course, the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Remember and understand the sources, types, and effects of air pollution, analyze weather influences and case studies, apply concepts related to climate change and pollution control technologies, evaluate environmental impacts and regulatory mechanisms like carbon trading, and create inovative air pollution abatement strategies pollution challenges and solutions	U, R, An, App,E,C	PSO-1, 2, 3, 7
CO-2	Acquire in-depth knowledge of water pollution, understand natural water characteristics, potable water sources, international and industrial water	U, R, An, App,E,C	PSO-1, 2, 3, 7

	quality standards, classification of pollution types, pollutant fate assessment, and critical evaluation of case studies on management strategies and emerging challenges in pollution control and create comprehensive water pollution management plans by designing innovative treatment systems,		
CO-3	Recall and understands 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. apply knowledge of sources, pathways, and effects of land pollution to assess contamination and disposal strategies, and create innovative waste management plans and pollution abatement solutions incorporating sustainable practices like the 3Rs and Cradle to Cradle concepts.	U, R, An, App,E,C	PSO-1, 2, 3, 7
CO-4	Gain a thorough understanding of noise pollution, remembering 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. And Apply methods to measure and assess noise pollution using sound monitoring equipment and noise mapping, evaluate the impacts of noise pollution on humans and animals within legal frameworks, and create effective noise control and management strategies tailored to different environmental and occupational issues	U, R, An, App,E,C	PSO-1, 2, 3, 7
CO-5	Remember the sources of 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.	U, AP, An	PSO-1, 2, 3, 7

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

Name of the Course: Environmental Science II- Environmental Pollution

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

CO No.	CO	PO/PSO	Cognitive Level	Knowledge Category	Lecture (L)/Tutorial (T)	Practical (P)
1	Remember and understand the sources, types, and effects of air pollution, analyze weather influences and case studies, apply concepts related to climate change and pollution control technologies, evaluate environmental impacts and regulatory mechanisms like carbon trading, and create inovative air pollution abatement strategies pollution challenges and solutions	PO1,6,8 / PSO-1, 2, 3, 7	U, R, An, App,E,C	F, C, P	L	P
2	Acquire in-depth knowledge of water pollution, understand 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 and create comprehensive water pollution management plans by designing innovative treatment systems,	PO1, 6, 8/ PSO-1, 2, 3, 7	U, R, An, App,E,C	F, C,P	L	P
3	Recall and understands 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	PO1, 6, 8/ PSO-1, 2, 3, 7	U, R, An, App,E,C	F, C,P	L	P

	decision-making in soil management and remediation efforts. apply knowledge of sources, pathways, and effects of land pollution to assess contamination and disposal strategies, and create innovative waste management plans and pollution abatement solutions incorporating sustainable practices like the 3Rs and Cradle to Cradle concepts.					
4	Gain a thorough understanding of noise pollution, remembering 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. And Apply methods to measure and assess noise pollution using sound monitoring equipment and noise mapping, evaluate the impacts of noise pollution on humans and animals within legal frameworks, and create effective noise control and management strategies tailored to different environmental and occupational issues	PO1, 6, 8/ PSO-1, 2, 3, 7	U, R, An, App,E,C	F, C,P	L	P
5	Remember the sources of 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	PO1, 6, 8/ PSO-1, 2, 3, 7	U, Ap, An	F, C	L	-

	for dark-sky preservation a sustainable lighting practic using case studies.					

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	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
8. Practicum

End Semester Evaluation

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

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	**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	2hours	-	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.	5

		Permitted feed additives and Advanced Ration Formulations for dairy and poultry (Brief description).	
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	Brief description of various breeds of poultry **Fowl**: Indigenous (Aseel, and Kadaknath) and Exotic breeds -Asiatic (Brahma), English (Orpington), Mediterranean (White Leghorn) and American class (Rhode Island Red). **Duck**: Nageswari, Kuttanad breed and Indian runner **Turkey**: Broad breasted Bronze **Quails:** Japanese breed	2
	3.3	Brief description of various breeds of cattle: **Cow**: Indigenous (Vechur cow, Kasaragod dwarf and Red Sindhi: Exotic (Jersey and Brown Swiss) **Buffalo**: Murah and Jaffarbadi **Sheep**: Barbari and Deccani. **Goat**: Malabari and Jamunapari.	2
	3.4	Breeding, Rearing and Housing of Cattle and Poultry.	3
IV	**Livestock Diseases and Management**		**10**
	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).	5
	4.2	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 - Vellayani Central Poultry Development Organization and Training Institute-Bangalore (Brief description).	3
	4.3	National Research Institutes: NDRI, CIRC, CIRG, NIVEDI and CARI (Brief description).	2
V	**Livestock Support, Registration, and Trends**		**5**
	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).	1
	5.2	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
	5.3	Commercialization of Livestock Products: KEPCO and MPI (Brief description)	1

	5.4	Emerging Trends in Livestock Management: Start-ups- Farm Tourism.	1

References

1. Aruna T. Kumar (2008). Handbook of Animal Husbandry, published by ICAR.
2. Banerji, G.C. A text book 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 Live Stock 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.	Topic
1.	Identification of Indigenous and Exotics breeds of Live stocks- Construct a chart showing their characteristic features (Cattle-6 numbers, Poultry- 6 numbers)
2.	Estimation of Casein from milk
3.	Analysis of quality of Milk- Methylene Blue Reductase test.
4.	Survey on the Challenges faced by poultry and dairy farmers. **OR** Visit to a Farm Tourism Centre and submit a detailed report.
5.	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

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, R, An, Ap, E, C	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, R, An, Ap, E, C	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, R, An, Ap, E, C	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.	R, U, An, Ap, E, C	PSO7
CO5	Serve as animal husbandry compendium for young entrepreneurs.	R, U, An, Ap, C, E	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	PO1/ PSO1	U	F	L	-
	their economic importance.					
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 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. Genetic breeds of Dairy.
2. Photography charts of Poultry.
3. Diseases of Dairy/ Poultry.
4. Incidence and effects of Bird flu in Kuttanadu.
5. Make a Short documentary on Farm Tourism.
6. Submission of any two-value added by -products**.**

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				

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 equip 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), Encyclopedia, 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 Sensitization**		**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, podcast 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.	Topic
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 report 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
5.	Submission of Minireview on a scientific topic **OR** Preparation of review of literature on any topic related to life sciences
6.	Prepare a list of Journals-Peer reviewed/Scopus indexed
7.	Prepare a template for a Scientific Project report
8.	Prepare a model of a Scientific Project proposal

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.	R, U, An, Ap, E, C	PSO1
CO2	Understand and evaluate various offline and online academic platforms, including peer-reviewed journals, conference proceedings, and databases like Google Scholar and PubMed, while identifying predatory journals.	R, U, An, Ap, E, C	PSO2
CO3	Explain different modes of life science communication and their use in biodiversity conservation, online media, and disaster awareness.	R, U, An, Ap, E, C	PSO2
CO4	Understand the components of scientific papers and apply best practices for clear, precise, and plagiarism-free scientific writing.	R, U, An, Ap, E, C	PSO7
CO5	Utilize digital and social media platforms to disseminate scientific information and engage with the public.	R, U, An, Ap, E, C	PSO7

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

Name of the Course: Life Science Communication and Popularisation
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 life science research and	PO1, PSO1	U	F, C	L	

	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. Finding Research Gaps using library resources.
3. Scientific poster / chart preparation/ oral presentation.
4. Modes of Life Science Communication.

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 discuss the current challenges and issues in bioeconomics and ecotourism, such as climate change, invasive species, over tourism, and socio-economic inequalities, and explore 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. (Brief account)	3
	1.2	Bioresource economics- Types- Natural resource economics	3

		Fisheries Economics and Forestry Economics- basic concept only.	
	1.3	Ecosystem Services- Provisioning Services, supporting services Regulating Services and Cultural services – basic concept only	4
II	**Trends in Bioeconomics and Policies**		**8**
	2.1	Green Economy- Biotechnology based economics, Environmental economics and Ecological economics. (Definition and brief account only)	3
	2.2	Assessment of the economic value of biodiversity and ecosystem services- Basic concepts only.	3
	2.3	Green production and sustainable consumption, Ecological Foot print.	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 Kerala.	4
	3.3	Major Ecotourism centres in Kerala - Kuruva, Thenmala, Gavi, Adavi and Ponmudi.	6
IV	**Impacts of Ecotourism on Biodiversity and Communities**		**8**
	4.1	Pros and Cons of ecotourism: Ecological, Socio-cultural, Economic and Environmental.	4
	4.2	Issues and Challenges- Invasive species, CO_2 emissions, water pollution, Biodiversity loss.	2
	4.3	Strategies for mitigating negative impacts and enhancing the benefits of ecotourism in India.	2
V	**Policies and Management for Sustainable Ecotourism**		**5**
	5.1	National and international policies and regulations governing ecotourism.	2
	5.2	Role of government agencies, NGOs and local communities in ecotourism management.	1
	5.3	Marketing Ecotourism- Definition, concepts and features: Brief account.	2

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/

Related Activities

1. Visit to the Ecotourism centers of Kerala and submit a short report with photos.
2. Recording of Invasive species in the Ecotourist regions at the time of study visit.
3. Marketing of beneficial products from forest.

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Define and apply the principles of bioeconomics and bioresource economics, evaluate ecosystem services and externalities, and analyze sustainable practices in biodiversity conservation and resource management.	R, U, An, Ap, E, C	PSO-1,2

CO-2	Summarize the principles of green, environmental, and ecological economics, apply methods for economic valuation of biodiversity and ecosystem services, and evaluate policy implications and property rights in the context of sustainable development and conservation	R, U, Ap, E, C	PSO-1,3
CO-3	Understand the scope and principles of ecotourism, apply planning and management strategies, and evaluate the role of ecotourism in conservation and sustainable development, with special reference to community-based initiatives in Kerala.	R, U, Ap, An, C, E	PSO-1,2
CO-4	Explain the ecological, socio-cultural, economic, and environmental impacts of ecotourism, and critically evaluate the issues and challenges such as biodiversity loss, pollution, and invasive species associated with ecotourism practices.	R, U, E, C, An, Ap	PSO-1
CO-5	Outline the national and international ecotourism policies, analyze the roles of stakeholders in ecotourism management, evaluate strategies to mitigate negative impacts, and explain the key concepts and features of ecotourism marketing.	R, U, An, E, C, Ap	PSO-.2

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 acquire 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 policies and analyse the impact of globalization, trade liberalization, and international agreements on bioeconomic sectors and policies.	PO 1/ PSO-1, PSO 2	U, An	F, C	L	-
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	PS O5	PS O6	PO1	PO2	PO3	PO4	PO5	PO6	P O7	P O8
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. Prepare a study report after visiting an ecotourism project nearby

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				