SEMESTER III

University of Kerala

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

Detailed Syllabus

Module	Unit	Content	45 hrs
I		**Introduction to Chordates**	**5**
	1.1	**Chordates:** Key characters (Notochord, Dorsal tubular nerve cord, Pharyngeal gill-slits) of Chordata (Brief account only).	2
	1.2	**Classification and Phylogeny:** Classical classification of chordates (Mention only). New trends in the classification of chordates based on molecular data and phylogenetic analyses (Cladogram) (Brief account only). Phylogenetic tree (Cladogram) of chordates (Brief account only).	3
II		**Non-vertebrate Chordates**	**4**
	2.1	**Non-vertebrate Chordates:** Evolutionary significance (Brief account only).	1
	2.2	**Tunicates:** General characters. Scientific classification, IUCN status, distribution, and salient features of Star tunicate (*Botryllus schlosseri*). Retrogressive metamorphosis in ascidian larvae (Brief account only).	2
	2.3	**Lancelets:** General characters. Scientific classification, IUCN status, habitat, salient features and feeding behaviour of European lancelet (*Branchiostoma lanceolatum*).	1
III		**Vertebrate Chordates**	**12**
	3.1	**Vertebrates:** An overview of evolution (Brief account only). Key characteristics and significant characteristics of vertebrates.	3
	3.2	**Fishes:** The origin of fishes (Brief account only). Key characteristics of fishes (Vertebral column, Jaws and paired appendages, Internal gills, Single-loop blood circulation, Nutritional deficiencies). Evolution of fishes (Brief account only).	3
	3.3	**Jawless Fishes (Agnathans):** General characters. Scientific classification, IUCN status, distribution, habitat, and salient features of Pacific hagfish (*Eptatretus stoutii*) and Sea lamprey (*Petromyzon marinus*) - Mention ecology, migration and invasiveness.	2
	3.4	**Cartilaginous Fishes (Chondrichthyes):** General characters. Scientific classification, IUCN status, distribution, habitat, salient features, and ecology of Spadenose shark (*Scoliodon laticaudus*) and Marbled electric ray (*Torpedo marmorata*) - Mention defence mechanism.	2
	3.5	**Bony Fishes (Osteichthyes):** General characters. Scientific classification, IUCN status, distribution, habitat, and salient features of Indian mackerel (*Rastrelliger kanagurta*) and Live sharksucker (*Echeneis naucrates)* - Mention adaptations.	2
IV		**Interesting Facts on Fishes**	**15**
	4.1	**Air-breathing Fishes:** Types of accessory respiratory organs in fishes. Brief account on accessory respiratory organs in Climbing perch (*Anabas testudineus),* Walking catfish (*Clarias batrachus*), Spotted snakehead (*Channa punctata*), Stinging catfish (*Heteropneustes fossilis),* European eel (*Anguilla Anguilla),* and Banded gourami (*Trichogaster fasciata).*	3
	4.2	**Fish Migration:** Mention types of migration. Classification of fishes based on migration (Anadromous and Catadromous). Significance and disadvantages of migration. Eg. Migration in European eel (*Anguilla anguilla*).	3
	4.3	**Blind Fishes:** General characteristics of cave-dwelling fishes, Threats and conservation., Very brief descriptions on the specialities of Meghalayan cave fish (*Neolissochilus pnar*), Cave goby (*Typhleotris madagascariensis*), Blind cave goby (*Typhleotris mararybe*), Blind electric ray (*Typhlonarke aysoni*), Blind catfish (*Horaglanis krishnai*), Waterfall climbing cave fish (*Cryptotora thamicola*), and Ozark cavefish (*Amblyopsis rosae*).	2
	4.5	**Common Indigenous Fishes of Kerala:** Brief descriptions on Distribution, habitat, vernacular names and threats of Denison barb/Miss Kerala (*Dawkinsia denisonii),* Gunther's catfish *(Horabagrus brachysoma),* Pearlspot (*Etroplus suratensis*).	3

	4.6	**Diversity of Invasive Alien fishes of India:** Ecological concern and effect of climate change. A case study on the invasion of the Suckermouth catfish (*Hypostomus plecostomus*). Brief descriptions of invasive alien fishes, Mozambique tilapia (*Oreochromis mossambicus*), Common carp (*Cyprinus carpio*), Striped catfish (*Pangasianodon hypophthalmus*), Orinoco sailfin catfish *(Pterygoplichthys multiradiatus),* Amazon sailfin catfish *(Pterygoplichthys pardalis)*, and Pirapitinga (*Piaractus brachypomus).*	4
V		**Amphibians**	**9**
	5.1	**Amphibians:** Origin (Brief account only). Distinguishing characteristics of amphibians (Legs, Lungs, Cutaneous respiration, Pulmonary veins and Partially divided heart). Evolution of amphibians (Brief account only).	3
	5.2	**Modern Amphibians:** **Frogs and Toads (Anurans):** General characters. Scientific classification, IUCN status, habitat, and salient features. of Malabar flying frog (*Rhacophorus malabaricus*). Mention Indian toad (*Duttaphrynus parietalis)* **Salamanders (Caudatans):** General characters. Scientific classification, IUCN status, habitat, salient features, neoteny and paedogenesis of Tiger salamander (*Ambystoma tigrinum)*. Mention Neoteny. **Caecilians (Apodans):** General characters. Scientific classification, IUCN status, distribution, and salient features of Kodagu striped Ichthyophis **(***Ichthyophis kodaguensi)*.	4
	5.3	**Parental Care in Amphibians:** Types (Direct nursing & nests). Brief account of parental care in Common midwife toad (*Alytes obstetricans*), Darwin's frog (*Rhinoderma darwinii*), Common Surinam toad (*Pipa pipa*), Horned marsupial frog (*Gastrotheca cornuta)*, Malabar flying frog (*Rhacophorus malabaricus*), and Ceylon caecilian (*Ichthyophis glutinosus*).	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 (30 hrs)

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

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

11	Isolation and temporary whole mount preparation of the Ctenoid scale of a fish (Minor practical).
12	Dissection and display the digestive system of any fish (Major practical).
13	Make a poster on the phylogeny of the living vertebrates (Use photographs/drawings, Group activity).
14	Make a poster showing major classes of fishes, typical examples (photographs/drawings) and key characteristics (Group activity).
15	PowerPoint presentation on Amphibian Orders (Anura, Caudata, and Apoda). Typical examples and Key characteristics of living Amphibians (Frogs, Toads, Salamanders, Newts, and Caecilians) must be included (Group activity).
16	Visit a local aquarium and make a report on five exotic ornamental fishes (Individual report).

References

Recommended Books:

1. Peter H. Raven, George B. Johnson, Kenneth A. Mason, Jonathan Losos, and Susan Singer, Carleton College (2017). Biology, 10th edition, McGraw Hill Education.
2. Young, J. Z. (2004). The Life of Vertebrates, 3rd Edition, Oxford University Press.
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2. Francis Day (2018). The Fishes of India, Vol. 2: Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Forgotten Books, Reprint.
3. Harvey Pough F. and Christine M. Janis (2019). Vertebrate Life, 10th Edition, Oxford University Press.
4. Richard D. Aldridge (2019). Handbook of Animal Diversity, CRC Press, ISBN 9781351089906, First Edition.
5. Kenneth Kardong (2019). Vertebrates: Comparative Anatomy, Function, Evolution. ISBN13: 9781259700910, 8th Edition.

Web Resources:

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

Course Outcomes

No.	Upon completion of the course the graduate will be able to	Cognitive Level	PSO addressed
CO-1	Gain proficiency in recognizing the distinctive traits and attributes of chordates and cultivate adeptness in identifying them through practical laboratory exercises.	U, Ap, An	1, 3, 6
CO-2	Understand and analyse key distinguishing features and evolutionary significance of cephalochordates and learn food and feeding strategies through practical laboratory sessions.	U, Ap, An	1, 2, 3, 6
CO-3	Understand and analyse the salient features of Tunicates and create awareness of their habitats.	U, Ap, An	1, 3, 6
CO-4	Gain a thorough understanding of the diversity and conservation considerations related to fishes, while enhancing visualization skills through the creation of posters and hands-on laboratory experiences.	U, Ap, An	1, 3, 5, 6, 7
CO-5	Gain insight into and analyse the critical distinguishing characteristics, ecological roles, and parental care behaviours observed in amphibians.	Ap, An	3, 7, 6

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

Name of the Course: Chordate Diversity -Part I

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

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

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

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

Mapping of COs with PSOs and POs

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

Correlation Levels:

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

Assessment Rubrics:

Assignments/Seminars (Any two)

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

Continuous Comprehensive Assessment

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

End Semester Evaluation

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

Mapping of COs to Assessment Rubrics:

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