



UNIVERSITY OF CALICUT

Abstract

General & Academic IV- Scheme & syllabus of Integrated M.Sc Bioscience programme (I & II semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CCSS) in the University Teaching Departments with effect from 2021 admission - Anomalies -Rectified-Approved-- Implemented - Orders issued.

G & A - IV - J

U.O.No. 559/2023/Admn

Dated, Calicut University.P.O, 12.01.2023

*Read:-*1. U.O.No. 17545/2022/Admn dated, 15.09.2022

2. Remarks from Chairperson, Board of Studies for M.Sc Biology/ Integrated M.Sc Biology & similar Bio science
3. Remarks of the Dean, Faculty of Science, dated 08.11.2022.
4. Item No.I.18 in the LXXXIV Academic Council meeting held on 15.12.2022
5. Orders of the Vice Chancellor in the file of even no. dated 04.01.2023

ORDER

1. The Scheme & syllabus of Integrated M.Sc Bioscience programme (I&II semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CCSS) with effect from 2021 admission, was implemented, vide paper read (1) above.
2. Chairperson, Board of Studies for M.Sc Biology / Integrated M.Sc Biology & similar Bio science courses forwarded the anomaly rectified syllabus of Integrated M.Sc Bioscience programme (I&II semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CCSS) with effect from 2021 admission vide paper read (2) above, after circulation among the board members as per Chapter 3(34) of Calicut University First Statute, 1976.
3. The anomaly rectified Scheme & syllabus of Integrated M.Sc Bioscience programme (I&II semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CCSS) with effect from 2021 admission, has been approved by the Dean, Faculty of Science, vide paper read (3) above.
4. The LXXXIV meeting of Academic Council approved the anomaly rectified Scheme & syllabus of Integrated M.Sc Bioscience programme (I&II semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CCSS) with effect from

2021 admission, vide paper read (4) above, and the Vice Chancellor has accorded sanction to implement the resolution of Academic Council, vide paper read (5) above.

5. Anomaly Rectified Scheme & syllabus of Integrated M.Sc Bioscience programme (I&II semester) in accordance with Regulations for the Integrated Programmes under Choice Based Credit Semester System (CCSS), is therefore implemented with effect from 2021 Admission.
6. Orders are issued accordingly. (Syllabus appended)

Ajayakumar T.K

Assistant Registrar

To

Director, School of Biosciences

Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE IV/JCE V/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

Scheme Integrated M.Sc Bioscience

The Integrated programme shall include nine types of courses, viz; Common courses (Code A), Core courses (Code B), Allied Core courses/Complementary courses (Code C), Open courses (Code D), Elective courses (Code E), Project (Code F), Comprehensive Viva (Code G), Practical/Lab (H), and Audit courses (Code I).

8.2 Course code: Each course shall have a unique alphanumeric code, which includes abbreviation of the type of programme (I), subject in three letters (BIO/PHY/CHE/MDS), the semester number (1 to 10) in which the course is offered, the type of the course (A to I) and the serial number of the course (01,02). For example: IBIO2B04 represents a core course of serial number 04 offered in the second semester of the Integrated Programme in Bioscience.

Semester	Code	Course	Credit	Hours/Week	T/P
Semester 1					
	IBIO1A01	Communicative English -1	3	3	T
	IBIO1B01	Animal diversity: Non Chordata	3	3	T
	IBIO1B02	Plant Diversity and Angiosperm Anatomy	3	3	T
	IBIO1C01	Chemistry 1	3	3	T
	IBIO1C02	Physics 1	3	3	T
	IBIO1C03	Mathematics 1	3	3	T
		Non Chordata Practicals		2	P
		Plant Diversity and Angiosperm Taxonomy Practicals		2	P
		Chemistry Practicals-1		2	P
		Physics Practicals-1		2	P
		Total	18	26	
Semester 2					
	IBIO1A02	Communicative English-2	4	4	T
	IBIO2B03	Animal diversity: Chordata	3	3	T
	IBIO2B04	Angiosperm morphology and systematic, plant utility and plant physiology	3	2	T
	IBIO2C04	Chemistry 2	3	3	T
	IBIO2C05	Physics 2	3	3	T
	IBIO2H01	Non-Chordata and Chordata Practicals	3	2	P

	IBIO2H02	Plant Diversity and Angiosperm Taxonomy : Angiosperm morphology and systematic, plant utility and plant physiology Practicals	3	3	P
	IBIO2H03	Chemistry Practicals-1	3	3	P
	IBIO2H04	Physics Practicals-1	3	3	P
			28	26	
Semester 3					
	IBIO3A03	Humanities and Social science	3	3	T
	IBIO3B05	Cell biology	3	3	T
	IBIO3B06	Ecology and Evolution	3	3	T
	IBIO3C06	Chemistry-3	3	3	T
	IBIO3C07	Biophysics and Instrumentation	3	3	T
	IBIO3C08	Computer Science -1	3	3	T
		Cell biology, Ecology and Evolution Practicals		2	P
		Chemistry Practicals -2		2	P
		CS Practicals -1		2	P
		Biophysics and Instrumentation- Practicals		2	P
			18	26	
Semester 4					
	IBIO4B07	Biomolecules	3	3	T
	IBIO4C09	Chemistry 4	3	3	T
	IBIO4C10	Biostatistics	3	3	T
	IBIO4C11	Computer Science -2	3	3	T
	IBIO4H05	Cell biology, Ecology and Evolution Practicals	3	3	P
	IBIO4H06	Chemistry Practicals -2	3	3	P
	IBIO4H07	CS Practicals -1	3	2	P
	IBIO4H08	Biophysics and Instrumentation and Biomolecules Practicals	3	3	P
	IBIO4H09	Biostatistics Practicals	3	2	P
			27	25	
Semester 5					
	IBIO5B08	Microbiology	4	4	T
	IBIO5B09	Genetics and Breeding	4	4	T
	IBIO5B10	Developmental Biology	4	4	T
	IBIO5H10	Microbiology Practicals	2	4	P

	IBIO5H11	Genetics and Breeding Practicals	2	4	P
	IBIO5H12	Developmental Biology Practicals	2	4	P
			18	24	
Semester 6					
	IBIO6B11	Animal Physiology	4	4	T
	IBIO6B12	Enzymology and Toxicology	4	4	T
	IBIO6B13	Environmental Biology	4	4	T
	IBIO6F01	Minor Project-1	2	4	Prj
	IBIO6H13	Animal Physiology Practicals	2	3	P
	IBIO6H14	Enzymology and Toxicology Practicals	2	3	P
	IBIO6H15	Environmental Biology Practicals	2	3	P
			20	25	
Semester 7					
	IBIO7B14	Molecular Biology	3	3	T
	IBIO7B15	Immunology & Immunotechnology	3	3	T
	IBIO7B16	Metabolism	3	3	T
	IBIO7D01	Open Elective -1	2	3	E
	IBIO7E01	Biology Elective-1	3	3	E
	IBIO7H16	Molecular Biology Practicals	2	3	P
	IBIO7H17	Immunology & Immunotechnology Practicals	2	3	P
	IBIO7H18	Metabolism Practicals	2	3	P
			20	24	
Semester 8					
	IBIO8B17	Structural Biology and Bioinformatics	3	3	T
	IBIO8B18	Biotechnology and Genetic Engineering	3	3	T
	IBIO8B19	Research Methodology, Bioethics and Scientific writing	3	3	T
	IBIO8D02	Open Elective -2	2	3	E
	IBIO8E02	Biology-Elective 2	3	3	E
	IBIO8F02	Minor Project 2	3	3	Prj
	IBIO8H19	Structural Biology and Bioinformatics Practicals	2	3	P
	IBIO8H20	Biotechnology and Genetic Engineering Practicals	2	3	P
			21	24	

Semester 9-10					
	IBIO10F0 3	Major Project	30	25	Prj
		Total Credits	200		

COMMENTS

Category wise credits verified

Course code	Credits
Code A	10
Code B	63
Code C	33
Code D	4
Code E	6
Code F	35
Code H	49
Total	200

Comments of changed made and errors

1. IBIO2H04 Credit corrected from 27 to 28
2. IBIO6H15 Hour corrected from 24 to 25
3. Switched course code IBIO2H02 with IBIO2H03
4. Rearranged codes IBIO4H06 - IBIO4H09
5. Cell biology, Ecology and Evolution practicals merged in 3rd sem
6. Biophysics and Instrumentation and Biomolecules Practicals corrected in 3rd sem
7. Practical uniformly changed to Practicals
8. Order of D and E courses interchanged
9. **"Research Methodology, Bioethics and" incomplete title noted**
10. **Finally change the colour codes and delete the comment part before submission**

Integrated M.Sc Bioscience syllabus

Semester I

Zoology Core Course

Animal Diversity:Non-Chordata

Course code: IBIO1B01

No. of Credits-3

Total hours 54

[Theory]

COURSE OUTCOMES (COs)

- To understand and apply the taxonomic Hierarchy, principles of nomenclature of the invertebrate phyla
- Students will understand the level of grade of animal organization and will explain their key features
- Students will understand different parasitic invertebrates and will explain their life cycle and transmission
- To understand the major insect pests and their control

Module I (4 hrs)

INTRODUCTION

Introduction to Zoology: Taxonomy-Definition, history, new trends and importance, mention molecular taxonomy. Components of classification, Taxonomical hierarchy – taxon, category and rank, Linnaean hierarchy, nomenclature, principles of nomenclature. International Code of Zoological Nomenclature (ICZN), rules of nomenclature, requisite-uni, bi and trinomialism. Mention taxonomic aids.

Module II (4 hrs)

Kingdom Protista: General characters, structure, zoological importance and systematic position of Actinophrys, Noctiluca, Paramecium and Opalina. Parasitic protozoans Morphology, life history, pathogenicity and prophylaxis of Entamoeba histolytica and Plasmodium vivax.

Module III (6 hrs)

Kingdom Animalia: Outlines of classification – Subkingdom Mesozoa, Subkingdom Parazoa, Subkingdom Eumetazoa. Levels of organization– cellular, tissue, organ. Divisions of Eumetazoa, Radiata, Bilateria, Acoelomata, Pseudocoelomata, Eucoelomata, Protostomia, Deuterostomia.

Sub kingdom Mesozoa- General characters, Example: Rhopalura.

Sub kingdom Parazoa

General characters, Mention the classes of Porifera

Classes:

Calcispongia, Example: Sycon

Hydrosporgia, Example: Euplectella

Desmospongia, Example: Spongilla.

General topic: Canal system in sponges.

Module IV (5hrs)

Subkingdom Eumetazoa

Phylum Coelenterata: General characters (self-study).

Classes:

Hydrozoa e.g., Obelia, (Obelia- Morphology and life cycle) Physalia;

Scyphozoa e.g., Aurelia;

Anthozoa e.g., Madrepora.

General topic: Polymorphism in coelenterates, Coral and Coral Reef.

Module V (9 hrs)

Phylum Platyhelminthes: General characters (self-study)

Classes:

Turbellaria, Example: Planocera

Trematoda, Example: Fasciola;

Cestoda, Example: *Taenia solium*.

Phylum Nematoda:

General characters (self-study), Parasitic Nematodes-Examples: *Ascaris*, *Ancylostoma*, *Enterobius*, *Wuchereria* [Morphology, life history, pathogenicity and prophylaxis], *Caenorhabditis elegans* (Brief account).

Phylum Annelida:

General characters and classification down to classes; salient features of the following classes

Classes:

Polychaeta, Example: *Nereis* – morphology and adaptations

Clitellata, (Mention subclass Oligochaeta and Hirudinea) Example: *Megascolex*-Morphology and nervous system

Hirudinaria –Adaptations and economic importance

Brief account of vermiculture –Methods and significance

Module VI (12 hrs)

Phylum Arthropoda:

General characters (self-study),

Penaeus – morphology, appendages, nervous system, reproduction and life cycle.

Mention prawn culture

Classification down to subphyla and classes; salient features of the following

Classes

Trilobita [brief account only]

Merostomata, Example: *Limulus* – mention evolutionary significance and medical use

Arachnida, Example: *Palaemon*, spider, mention ticks and mites

Myriapoda, Examples: *Scolopendra*, *Spirostreptus*

Crustacea, (Superclass Crustacea) Example: *Sacculina*, *Eupagurus*

Insecta, Examples: *Troides*, *Minos*

Mouthparts of different insects – cockroach, honeybee, mosquito, butterfly, Pollen basket

Economically important insects:

- a) Agriculture pests -Type of damage and control of Oryctes and Leptocoryza
- b) Insects of medical importance – mention disease transmitted and control of mosquitoes and sandfly;
- c) Beneficial insects – Honey bee – mention different species, brief account of apiculture, role as pollinators; *Bombyx mori* – brief account of sericulture and its significance.

Phylum Onychophora:

General characters, Example: Peripatus (Evolutionary significance).

General topic: Sericulture

Module VII (8 hrs)

Phylum Mollusca:

General characters (discuss types and ultrastructure of shell, mantle and mantle cavity, radula, torsion and coiling)

Classification down to classes; salient features of the following classes

Classes:

Polyplacophora, example: Chiton

Bivalvia, Example: Perna

Scaphopoda, Example: Dentalium

Gastropoda, Example: Pila

Cephalopoda, Example: Loligo, Sepia

Monoplacophora, Example: Neopilina;

General topic- Economic importance of Mollusca, Pearl culture, Mussel culture.

Phylum Echinodermata: (4hrs)

General characters (self-study)

Classes

Asterozoa, Example: Asterias;

Ophiurozoa, Example: Ophiothrix;

Echinozoa, Example: Echinus;

Holothuroidea, Example: Sea cucumber,

Crinoidea, Example: Sea lily.

General Topic: Water vascular system.

Phylum Hemichordata: (2hrs)

Salient features and Example: Balanoglossus

Minor Phyla

1. Chaetognatha- Example: Sagitta

2. Sipunculida- Example: Sipunculus

NB: Assignments/ Seminar-Topics related to syllabus can be given to students as assignment/ seminar.

Topics for assignments/seminars (Topics allotted for assignments/ seminars should be considered for internal assessments only, and can be subdivided among students)

1. Nutrition in protozoans.
2. Reproduction in protozoans.
3. Parasitic protozoans of man.
4. Helminth parasites of man.
5. Reef building corals and coral reefs.

References:

- Anderson, D. T. (2001). Invertebrate Zoology. 2nd edition. University of Michigan, Oxford University Press (Indian Edition. 2006).
- Apte, D. (2015). Sea Shells of India: An Illustrated Guide to Common Gastropods. Bombay Natural History Society & Oxford University Press, New Delhi.
- Barnes, R.D. (1987). Invertebrate Zoology. W. B. Saunders. New Delhi.
- Barnes, R.S.K., Calow, P.P., Olive, P.J.W., Golding, D.W. & Spicer, J.I. (2009).

The Invertebrates: A Synthesis, 3rd Edition. Wiley Blackwell Science, UK.
Barrington E.J.W. (1967). Invertebrate Structure and Function. ELBS and Nelson, London.

- Bhatnagar, M.C. & Bansal, G. (2014). Non–Chordata (Invertebrate Zoology).

Krishna Prakashan Media (P) Ltd., Meerut.

- Brusca, R.C. & Brusca, G.J. (2002). Invertebrates, 2nd Edition. Sinauer Associates, OUP London.
- Buchsbaum, R., Buchsbaum, M., Pearse, J. & Pearse V. (2013). Animals without Backbones: An Introduction to the Invertebrates. University of Chicago Press, USA.
- Cotes, E. C. (2011). A Catalogue of the Moths of India. Nabu Press, India. ·Dhami, P. S. & Dhami, J. K.: Invertebrate Zoology. R. Chand & Co, New Delhi.
- Dhami, P.S and Dhami, J. K. (1979). Invertebrate zoology. R. Chand & Co. New Delhi.
- Ekambaranatha Ayyar M. (1990). A Manual of Zoology. Vol. 1. Invertebrata- Part 1 & Part 11. S. Viswanathan Printers and Publishers. Pvt. Ltd.
- Hooper, J. N.A. & van Soest, R. W. M. (2006). Systema Porifera: A Guide to the Classification of Sponges. Springer Publications.
- Hyman, L. H. (1942). The invertebrate volumes. Mc Graw - Hill.
- Jordan, E.L and Verma, P.S. (2001). Invertebrate Zoology. S. Chand and Co Ltd. New Delhi.
- Kehimkar, I. (2016). Butterflies of India. Bombay Natural History Society, Mumbai.
- Kiran, C. G. & Raju, D. V. (2013). Dragonflies and Damselflies of Kerala: A Bilingual Pictorial Guide. Tropical Institute of Ecological Studies, Kottayam.
- Kotpal, R. L. (2009). Modern Textbook of Zoology: Invertebrates. Rastogi Publications, New Delhi.

- Kozloff, E.N. (1990). Invertebrates. University of Michigan & Saunders College Publishing, 1990
- Kunte, K. (2000). Butterflies of Peninsular India. Universities Press, Hyderabad & Indian Academy of Sciences, Bangalore
- Mandal, F.B. (2017). Biology of Non-chordates. PHI Learning Pvt. Ltd., New Delhi.
- Mayr, E. (1980). Principles of Systematic Zoology. Tata McGraw-Hill Publishing, New Delhi.
- Mayr, E. & Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd edition, 1991, McGraw-Hill Publishing Inc., New York.
- Marshall, A. J. and Williams, W. D. (1972). Text book of zoology vol. 1 Invertebrates. ELBS & MacMillan, London.
- McClanahan, T. R., Sheppard, C. R. C. & Obura, D. O. (2000). Coral Reefs of the Indian Ocean: Their Ecology and Conservation. Oxford University Press, USA.
- Meglitsch, P.A. & Schram, F.R. (1991). Invertebrate Zoology. Oxford University Press.
- Moore, J. (2001). An Introduction to the Invertebrates. Cambridge University Press, London.
- Nigam, S. (1978). Invertebrate Zoology. S. Nigam & Co.
- Parker, T.J and Haswell, W. A. (1962). Text book of Zoology. Vol.I Invertebrate. LBS and MacMillan, London.
- Pearse, V., Pearse, J., Buchsbaum, M. and Buchsbaum, R. (1987). Living Invertebrates. Blackwell Scientific Publications, California.
- Pechenik, J. A. (2015). Biology of the Invertebrates. 7th illustrated edition. McGraw-Hill Education, 2015.
- Puranik, P. & Bhate, A. (2008). Animal Forms and Functions: In vertebrata. Sarup & Sons, New Delhi.
- Ruppert, E.E., Fox, R. and Barnes, R.D., (2004). Invertebrate Zoology. Thomson Books/Cole, U.S.A.
- Sandhu, G.S. (2005). Textbook of Invertebrate Zoology, Volume I. University of California & Campus Books International, New Delhi.
- Singh, A. P. (2010). Butterflies of India. Om Books, New Delhi
- Smetacek, P. (2016). A Naturalist's Guide to the Butterflies of India. Prakash Books India Pvt. Ltd., New Delhi
- The New Encyclopedia Britannica. Macropedia. 15th Ed. 1998. Encyclopedia Britannica Inc. Chicago.
- Verma, A. (2005). Invertebrates: Protozoa to Echinodermata. Alpha Science Intl., Oxford.

CORE COURSE ZOOLOGY PRACTICALS 1
ANIMAL DIVERSITY: NONCHORDATA

Total hours 36

Course outcomes:

- Achieve practical efficiency in classification of animals
- To understand the method of biological specimen preparation

MODULE 1. [36 hrs]

Section A. Students are expected to make sketches with notes, while they study the specimens in the laboratory/field itself. The record must carry sketches with notes of all specimens, mountings and dissections. Emphasis must be on scientific accuracy and not on beauty of sketches. Study of the following non-chordate specimens:(All animals intended for type study are to be included. Slides / museum preparations are to be used; charts / models may be used in exceptional cases. Students are expected to identify the specimens by their generic names and assign them to the respective phyla and classes).

Section A

Identification, Classification up to class and brief note of the following specimens.

1. Kingdom Protista – Actinophrys, Noctiluca, Pramecium, Opalina – any 2
2. Phylum Porifera – Euplectella, Spongilla- any 1
3. Phylum Cnidaria – Hydra, Obelia, Physalia, Aurelia, Sea anemone, Madrepora – any 3

4. Phylum Nematoda – Ascaris- male and female (entire)
5. Phylum Platyhelminthes – Bipalium, Fasciola, Teaniasolium – any 1
6. Phylum Annelida – Earthworm, Nereis, Leech, Aphrodite, Arenicola – any 1
7. Phylum Onychophora – Peripatus
8. Phylum Arthropoda – Cockroach, Limulus, Eupagurus, Sacculina, Honey bee, Lepisma, Scorpion – any 3
9. Phylum Mollusca – Chiton, Pila, Xancus, Dentalium, Perna, Mytilus, Teredo, Sepia, Octopus. – any 2
10. Phylum Echinodermata – Starfish, Brittle star, Sea urchin, Sea cucumber, Sea lily – any 2

Section B-Histology

Transverse sections of a coelenterate [Hydra], a platyhelminth [Dugesia] and a nematode (Ascaris male & female).

Section C.

Minor Practical - Any four.

1. Nereis – parapodium
2. Earthworm – body setae
3. Cockroach – Digestive system
4. Cockroach – mouth parts
5. Honey bee – mouth parts / mosquito - mouth parts
6. Prawn – appendages (Any Three- Maxillipeds 1,2,3, Chelate leg, first abdominal appendage)

Section D-Major Practical – (Any Two)

1. Earthworm – nervous system
2. Cockroach – nervous system
3. Prawn – nervous system

References:

- Apte, D. (2015). *Sea Shells of India: An Illustrated Guide to Common Gastropods*. Bombay Natural History Society & Oxford University Press, New Delhi.
- EkambaranathaAyyar, M. &Ananthakrishnan, T. N. (1985). *A Manual of Zoology*. Vol. II Part I & II. · Ghose, K. C. & Manna, B. (2007). *Practical Zoology*. New Central Book Agency (P) Ltd, New Delhi.
- Hooper, J. N.A. & van Soest, R. W. M. (2006). *Systema Porifera: A Guide to the Classification of Sponges*. Springer Publications.
- Jordan, E. L. & Verma, P. S. (2007). *Invertebrate Zoology*. S. Chand & Co. Publishing, New Delhi.
- Kotpal, R. L. (2011). *Modern Text Book of Zoology - Invertebrates*; Rastogi Publications, India.
- Kunte, K. (2000). *Butterflies of Peninsular India*. Universities Press, Hyderabad & Indian Academy of Sciences, Bangalore.
- Lal, S. S. (2009). *Practical Zoology- Invertebrates*. 11th Edition.Rajpal and Sons Publishing, New Delhi.
- Mandal, F. B. (2012). *Invertebrate Zoology*. PHI Learning Pvt. Ltd., India.
- Sleight, M. A. (1989). *Protozoa and other Protists*. E. Arnold Publishers Ltd., UK.
- Shubhalaxmi, V. & Kendrick, R. (2018). *Field Guide to Indian Moths*. Birdwing Publishers, Mumbai.
- Venkataraman, K. (2003). *Handbook on Hard Corals of India*. Zoological Survey of India, Kolkata.
- Verma P. S. (2000). *A Manual of Practical Zoology: Invertebrates*. S. Chand Publishers, New Delhi.

Integrated M.Sc Bioscience syllabus

Semester I

Botany Core Course

PALNT DIVERSITY & ANGIOSPERM ANATOMY

Course code: IBIO1B02

Credit 3

Course Outcomes

1. Understanding diversity in morphology, anatomy, reproduction and life cycle in all groups of plants.
2. Skill Development in collection and preservation of different groups of plants.
3. Realizing the economic/ecological importance of plants.
4. Understanding the evolutionary lineages in plants starting from thallophytes to seed plants.
5. Skill development for the proper description, identification and classification of plants through morphological, anatomical and life cycle studies.
6. Awareness on the morphological, anatomical and reproductive features of primitive and advanced plants with an evolutionary link between them.
7. Appreciation of human activities in conservation of useful plants from the past to the present.
8. Observation of variations that exist in internal structure of various parts of a plant and as well as among different plant groups in support for the evolutionary concept.
9. Induction of the enthusiasm on internal structure of locally available plants.
10. Understanding various levels of organization in a plant body with an outlook in the relationship between the structure and function through comparative studies.

PLANT DIVERSITY

Algae

Introduction: General characters, habitat diversity, thallus structure, pigments, reservefood, flagella types, life cycle and alternation of generations in algae. Evolutionary trends and affinities with microbes and bryophytes. A brief account of the Classification of Algae by C. Van Den Hoek *et al.* (1995).

Salient features, thallus structure and reproduction in algae in the following groups with special reference to the types mentioned (developmental details are not required): Chlorophyta – (*Chlamydomonas*, *Volvox*, *Oedogonium*, *Chara*); Xanthophyta (*Vaucheria*); Bacillariophyta (*Pinnularia*); Phaeophyta (*Sargassum*).

Industrial Phycology: bioactive compounds from algae, sea weed polysaccharides like Agar, carrageenin and alginates, diatomite.

Applied aspects: biofuel production, food supplements, pharmaceutical industries, algal blooms, commercial cultivation of algae.

Ecological importance of algae.

BRYOPHYTES

Introduction, general characters and classification of bryophytes.

General account of the anatomy, reproduction and life history of Marchantiales, Jungermanniales, Polytrichales and Anthocerotales

Distribution, morphology, anatomy, reproduction and life cycle of the following types (developmental details are not required): Hepaticopsida - *Riccia*, Anthocerotopsida - *Anthoceros*; Bryopsida - *Funaria*.

Evolutionary trends and affinities with Algae and Pteridophytes.

Evolution of gametophyte and sporophyte among Bryophytes.

Applied bryology: ecological uses, household uses, medicinal uses (herbal medicines, transgenic products), decorative bryophytes, aquarium bryophytes, heavy metal detection and clean up, erosion control, horticultural uses (soil conditioning, air layering, pot culture, container gardens and hanging baskets), bioindicators of pollution.

Fossil bryophytes: a general account

PTERIDOPHYTES

1. Introduction: A brief account of the general characteristics. Habitat diversity with special reference to South Indian Pteridophytes.
2. Classification: An outline of recent system of classification of Pteridophytes (PPG).
3. Endemic and endangered Pteridophytes of South India.
4. Stellar organization, telome theory.
5. Apogamy, apospory and apomixis.
6. Ecological and economic significance of Pteridophytes with special reference to water ferns (*Azolla*, *Salvinia*)
8. A brief account on the diversity, distribution, habitat, external and internal morphology and mechanism of reproduction of the following orders with special reference to the types given in brackets (developmental details are not required). Rhyniales (*Rhynia*) Psilotales (*Psilotum*), Selaginellales (Selaginella), Equisetales (*Equisetum*), Salviniiales (*Marsilea*), Filicales (*Pteris*).

GYMNOSPERMS

Introduction - Salient features, distribution and Classification (by Sporne).

Study of the habitat, distribution, habit, anatomy, reproduction and life cycle of *Cycas*, *Pinus* and *Gnetum* (Developmental details not required).

A brief account of the following orders: Pteridospermales, Glossopteridales, Caytoniales, Cycadeoidales, Pentoxylales, Cycadales, Ginkgoales, Coniferales, Taxales, Ephedrales.

Ecological and Economic importance of gymnosperms.

A brief account of geological time scale.

ANGIOSPERM ANATOMY

Introduction, objective and scope of plant anatomy.

Plant Tissues: Meristems – classification, characteristics. Theories of root and shoot apex organizations.

Permanent tissues – classification, characteristics, simple, complex and secretory tissues.

Structure of plant body: Brief introduction to Primary vegetative body of the plant - root, stem, leaf in Dicots and Monocots.

Tissue systems in Plants - Epidermal and Vascular tissue systems. Detailed description of secondary growth in root and stem - development and function of vascular cambium. Extrastelar secondary growth and periderm formation. Cambium in wound healing and grafting. Anomalous secondary growth (*Boerhavia*).

CORE COURSE BOTANY PRACTICALS 1

PALNT DIVERSITY & ANGIOSPERM ANATOMY

1. Conduct a field visit to any one of the ecosystems rich in Algae to experience algal diversity. Submit a report with photographs.
2. Make micro-preparations of vegetative and reproductive structures of *Volvox*, *Oedogonium*, *Chara* and *Sargassum*.
3. Familiarizing the technique of algal collection preservation and culture of algae.
4. Conduct a field visit to any one of the ecosystems to study bryophytes and submit a report with photographs.
5. Study the habit, anatomy of thallus and reproductive structures of *Riccia*, *Anthoceros*, *Marchantia*.
6. Familiarizing the technique of bryophyte collection and preservation.
7. Pteridophytes: Study the morphology, anatomy and reproductive structures of *Psilotum*, *Selaginella*, *Equisetum*, *Pteris*, *Marsilea*.
8. Gymnosperms: *Cycas*, *Pinus*, *Gnetum*.
9. Simple permanent tissues – Parenchyma, Chlorenchyma, Aerenchyma, Collenchyma and Sclerenchyma.
10. Complex permanent tissues: Xylem and Phloem

11. Epidermal structures – Trichomes, Glands, Stomata- dicot, monocot, anomocytic, diacytic, paracytic, anisocytic.
12. Primary structure: Dicot stem, Monocot stem, Dicot root, Monocot root, Leaf Anatomy – Dicot leaf and monocot leaf.
13. Secondary structure: Dicot stem and root.
14. Anomalous secondary thickening – *Boerhavia*.

REFERENCES

1. Kumar, H.D. 1999. *Introductory Phycology*. Affiliated East-West Press, New Delhi.
2. Lee, R.E. 2008. *Phycology*, Cambridge University Press, Cambridge.
3. Sambamurthy A.V.S.S. 2005. *A Text book of Algae*, Mittal Books India.
4. Vanderpoorten, A. & Goffinet, B. 2009. *Introduction to Bryophytes*. Cambridge University Press, Cambridge.
5. Bhatnagar S.P. & Moitra A. 1996. *Gymnosperms*. New Age International.
6. Bir, S.S. 2005. *Pteridophytes their Morphology, Cytology, Taxonomy and Phylogeny*. Today & Tomorrow's Printers and Publisher.
7. Biswas, C. & B.M. Johri 2004. *The Gymnosperms*, Narosa Publishing House, New Delhi.
8. British Columbia Ministry of Forests.1996. Techniques and procedures for collecting, preserving, processing, and storing botanical specimens. Res. Br., B.C. Min. For., Victoria, B.C. Work. Pap.
9. Campbell, C.J. 1940. *Evolution of land Plants*, Stanford University Press.
10. Coulter J.M. & C.J. Chamberlain 1978. *Morphology of Gymnosperms*, Central Book Depot, Allahabad.
11. Eames, A.J. 1974. *Morphology of Vascular Plants - lower groups*, Tata Me Graw-Hill Publishing Co. New Delhi.
12. Foster, A.S. & F.M. Gifford 1967. *Comparative morphology of vascular plants*, Freeman Publishers, San Fransisco.
13. Kakkar, R.K. & B.R. Kakkar 1995. *The Gymnosperms (Fossils and Living)*. Central Publishing House, Allahabad.
14. Parihar, N.S. 1976. *The biology and morphology of the pteridophyta*, Central Book Depot, Allahabad.

15. Rashid, A. 1976. *An introduction to pteridophyta*, Vikas Publishing House Ltd., New Delhi.
16. Sambamurty A.V.S.S. 2005. *A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany*, Today & Tomorrow's Printers and Publishers.
17. Sharma O.P. 2002. *Gymnosperms*, Pragati Prakashan, Meerut.
18. Sharma P.N. & Sahni K.C. 2005. *Gymnosperms of India and Adjacent Countries*. Bishen Singh Mahendra Pal Singh, Dehradun.
19. Sporne, K.R. 1976. *Morphology of Pteridophyta*. Hutchinson University Library, London.
20. Sundrarajan S. 2009. *Introduction to Pteridophyta*, New Age international (Pvt) Ltd.
21. Sundararajan S. 2002. *Practical Manual of Pteridophyta*, Anmol Publishers.
22. Hoek, C.V.D., Mann, D.G. & Jahns, H.M. 1995. *Algae. An Introduction to Phycology*. Cambridge University Press, Cambridge. 1995.
23. Coutler E.G., 1969. *Plant Anatomy – Part I Cells and Tissues* – Edward Arnold, London.
24. Esau K., 1965. *Plant Anatomy*, Wiley Eastern, New York.
25. Fahn A., 1985. *Plant Anatomy*, Pergamon Press, Oxford.
26. Pandey, B.P. 1997. *Plant Anatomy*, S. Chand and Co. New Delhi.
27. Vashishta P.C .1984. *Plant Anatomy* – Pradeep Publications – Jalandhar.
28. Pijush Roy 2010. *Plant Anatomy*. New Central Book Agency, New Delhi.

Integrated M.Sc Bioscience syllabus

Semester II

Zoology core course

ANIMAL DIVERSITY: CHORDATA

Course code: IBIO2B03

[54 hours] [3 hours per week] [3 credits]

Course Learning Objective:

This course is designed to provide adequate knowledge on the Evolutionary history of Chordates, in continuation with non-chordates. It will impart basic concepts of origin and Evolution of chordates and make the learners understand animals' diversity, characteristics, and classification with notochord/vertebral columns. In addition, the exclusive phenomena in chordate adaptations will be narrated.

COURSE OUTCOMES [COs]

Upon completion of the course, the students will be able to:

CO1 Understand different classes of chordates, level of organization and evolutionary, Relationships and significance between different subphyla and classes of Chordates

CO2 Describe the salient features and affinities of subphylum Urochordata; elucidate the morphology and structural organization of *Ascidia*

CO3 Describe the salient features and affinities of subphylum Cephalochordata; elucidate the morphology and structural organization of *Branchiostoma*

CO4 Enumerate the salient features of superclass Pisces and illustrate its classification down to orders and the morphology and structural organization of *Scoliodon*

CO5 Describe the salient features and affinities of class Amphibia and its classification up to orders; explain the morphology and organ systems of *Hoplobatrachus tigerinus*

CO6 Elucidate the characteristic features of the class Reptilia and its classification down to orders; describe the morphology and organ systems of *Calotes versicolor*

CO7 Describe the classification of class Aves down to orders, salient features of each order with suitable examples and Elucidate the external characters and functional systems of *Columba livia*

CO8 Enumerate the salient features and classification of class Mammalia down to orders with suitable examples and Elucidate the external characters and functional systems of *Oryctolagus cuniculus*

CO9 Compare the circulatory, excretory and nervous systems of different vertebrates

[Type studies with special emphasis on morphology and various functional systems such as integumentary, digestive, respiratory, circulatory, excretory, nervous and reproductive systems. Mention the evolutionary significance and adaptations]

MODULE 1. [5 hrs]

Introduction [1hrs]

Chordate characters -(fundamental, general and advanced); chordates versus nonchordates; diversity of chordates; outline classification down to classes; salient features of each subphylum.

Subphylum UROCHORDATA [Tunicata] [2 hrs]

Classification of the subphylum down to classes. Affinities of urochordates with cephalochordates and vertebrates.

Class Ascidiacea e.g. Herdmania

Class Larvacea e.g. Oikopleura

Class Thaliaceae.g. Doliolum

Type: Ascidia [Morphology and retrogressive metamorphosis]; neoteny and paedogenesis.

Subphylum CEPHALOCHORDATA [2 hrs]

Type: Branchiostoma [=Amphioxus]

Morphology and anatomical features; digestive system in detail; primitive, degenerate and specialized features [affinities and systematic position to be emphasized).

MODULE 2.

Subphylum VERTEBRATA [9 hrs]

Salient features of subphylum vertebrata and its outline classification down to classes.

Division 1. AGNATHA

Characters, classification down to classes and examples: Myxine; Petromyzon. Mention Ammocoetes larva

Division 2. GNATHOSTOMATA

Classification of Pisces down to orders; salient features of the following extant groups:

Class Chondrichthyes [Cartilaginous fishes]

Subclass Selachii e.g. *Scoliodon*, *Trygon*

Subclass Holocephali e.g. *Chimaera*

Class Osteichthyes [Bony fishes]

Subclass Sarcopterygii

1. Order Crossopterygii [Coelacanths] e.g. *Latimeria*

2. Order Dipnoi [Lung fishes], e.g. *Neoceratodus*, *Protopterus*, *Lepidosiren*
(Add a note on the distribution of lung fishes).

Subclass Actinopterygii

1. Superorder Chondrostei e.g. *Acipenser*

2. Superorder Holostei e.g. *Amia*, *Lepidosteus*

3. Superorder Teleostei [Spiny-rayed fishes] e.g. *Sardinella*, *Rastrelliger*

Type: Type: *Scoliodon* (Dog Fish/Shark)

[Morphology, digestive system, respiratory system, circulatory system, excretory system, sense organs (neuromast organ in detail) and reproductive system].

Sub-terranean fishes from Kerala: *Aenigmachanna Gollum* (Gollum Snakehead), *Kryptoglanis shajii*, *Horaglanis krishnai* (Blind Catfish) & *Monopterus digressus* (Blind cave eel).

Mention recent addition to ornamental fish trade – *Sahyadria denisonii* (roseline shark / Denison barb/Miss Kerala).

Super class TETRAPODA

MODULE 3. Class AMPHIBIA [9 hrs]

Classification of Amphibia down to orders with examples.

Subclass Stegocephalia (extinct)

Subclass Lissamphibia

1. Order Apoda (=Gymnophiona) e.g. *Ichthyophis*, *Uraeotyphlus*

2. Order Caudata (=Urodela) e.g. *Necturus*, *Ambystoma*, mention Axolotl larva

3. Order Anura (=Salientia) e.g. *Duttaphrynus*, *Rhacophorus*

Type: *Hoplobatrachus tigerinus* (Indian Bullfrog)

[Morphology, body wall, skeletal system, digestive system, respiratory system, circulatory system, excretory system, sense organs (brief details) and reproductive system].

Mention the diversity of bush frogs, dancing frogs and night frogs in the Western Ghats and the discovery of *Nasikabatrachus sahyadrensis* (Purple frog).

Seminar/assignments topics : Parental care; Geographical distribution pattern; edible/poisonous/desert amphibians; Glass frog; hibernation/aestivation/ camouflage; amphibians in medicine

MODULE 4. Class REPTILIA [9 hrs]

Classification of class Reptilia down to orders and salient features of the following orders

Subclass I - Anapsida

1. Order Cotylosauria [stem reptiles] e.g. *Captorhinus*
2. Order Chelonia [common turtles, tortoises etc.], e.g. *Melanochelys*, *Chelone mydas*, Olive ridley turtles (*Lepidochelys olivacea*), *Geochelone elegans* (formerly *Testudo elegans*, star tortoise);

Subclass 2: Lepidosauria

1. Order Eosuchia eg. *Youngina*
2. Order Rhynchocephalia eg. *Sphenodon*
3. Order Squamata

Suborder Ophidia (serpentes) eg: Anaconda (*Eunectes murinus*), Rattle snake (*Crotalus*)

Brief notes on common poisonous and non-poisonous snakes of Kerala.

Poisonous snakes: King Cobra, Common Indian Cobra; Vipers: Russell's viper (*Daboia*), saw scaled viper (*Echis carinatus*), *Bungarus caeruleus* (Krait); slender Coral snakes (*Callophis*), Sea snakes (*Enhydrina*).

Non- Poisonous snakes: *Zamemis (Ptyas)*, *Typhlops*, *Eryx conicus*, *Dryophis*, Indian rock python (*Python molurus*), *Uropeltis*, *Natrix*.

Suborder Lacertilia (Sauria)
eg: *Chamaeleon*, *Draco*, *Phrynosoma*, *Varanus monitor*, *Hemidactylus*, *Mabuya*, *Iguana*, *Varanus komodoensis* (Komodo dragon), *Heloderma*

Suborder Amphisbaenia (worm lizards).
eg: *Amphisbaena*

Subclass 3 Archosauria

1. Order Thecondontia eg. *Euprarkeria*
2. Order Pterosauria (Flying reptiles)
3. Order *Saurischia*
4. Order *Ornithischia*
5. Dinosaurs : *Tyrannosaurus*, *Brontosaurus*, *Stegosaurus*, *Triceratops*
6. Order Corocodilia
eg: *Crocodylus*, The mugger crocodile (*Crocodylus palustris* = "crocodile of the marsh"); saltwater crocodile(*Crocodylus porosus*, saltie,estuarine crocodile), Gavialis(*Gavialis gangeticus*), Alligators : American alligator (*A.mississippiensis*) and the Chinese alligator (*A. sinensis*)., Caimans.

Subclass 4. Synapsida: Mammal like reptiles : *Dimterodon*, *Cynognathus*, *Tritylodon*

Extinct Aquatic reptiles (Subclass Parapsida of earlier classification)

1. Order Ichthyosauria eg.*Ichthyosaurus*;
2. Order *Plesiosauria* eg. *Plesiosaurus*, *Elasmosaurus*

Type: *Calotes versicolor* (Garden Lizard)

[Morphology, digestive system, circulatory system, excretory system and reproductive system].

Seminar/assignments topics : extinction of dinosaurs; Komodo dragon, Crocodiles and anapsids as unrecognised living fossils.

MODULE 5.[9 Hrs]

Classification of Aves

Classification of class Aves down to the orders specified; mention at least one example for each order.

Subclass Archaeornithes

1. Order Archaeopterygiformes, e.g.*Archaeopteryx lithographica* - a brief account of its discovery and evolutionary significance.

Subclass Neornithes

Super order Palaeognathae [=Ratitae]

2. Order Casuariiformese.g.Casuarius (Cassowary)
3. Order Dinornithiformes [=Apterygiformes] e.g. Apteryx (Kiwi)
4. Order Rheiformese.g. Rhea
5. Order Struthioniformes e.g. Struthio (Ostrich)

Super order Neognathae [=Carinatae]

6. Order Galliformes [pheasants, quail, turkeys, grouse] e.g. *Pavocristatus*
7. Order Anseriformes [screamers, water fowls] e.g. *Anas poecilorhyncha*
8. Order Passeriformes [perching birds] e.g. *Passer domesticus*
9. Order Piciformes [woodpeckers, barbets, honeyguides] e.g. *Dinopium*
10. Order Coraciiformes [kingfishers & allies] e.g. *Alcedoatthis*
11. Order Apodiformes [swifts, humming birds] e.g. *Apus nipalensis*
12. Order Strigiformes [owls] e.g. *Bubo*
13. Order Cuculiformes [cuckoos, roadrunners, turacos] e.g. *Eudynamys*
14. Order Psittaciformes [parrots, lories, cockatoos] e.g. *Psittaculakrameri*
15. Order Gruiformes [cranes, rails, coots, bustards] e.g. *Ardeotisnigriceps*
16. Order Charadriiformes [plovers, gulls, terns, auks, sand pipers]
e.g. *Tringa*
17. Order Columbiformes [pigeons, doves, dodos, sand grouse] e.g.
Columba
18. Order Falconiformes [diurnal birds of prey – falcons, hawks] e.g. *Myiavus*
19. Order Ciconiiformes [herons, storks, ibis, spoon bills] e.g. *Ardeolagrayii*
20. Order Pelecaniformes [pelicans, cormorants] e.g. *Pelecanus*
21. Order Sphenisciformes [Impennae] e.g. *Aptenodytes* (penguin)
22. Order Phoenicopteriformes [flamingos] e.g. *Phoenicopterus*

Recent Extinctions: Passenger Pigeon [*Ectopistes migratorius*], Dodo [*Raphus cucullatus*], Pink-headed Duck [*Rhodonessa caryophyllacea*], Elephant Bird [*Aepyornis*].

Rediscovery of Jerdon's Courser [*Cursorius bitorquatus*] & Forest Owlet [*Athene blewitti*].

Type: *Columba livia* (Rock Pigeon)

[External characters, structure of feather in detail – exclude development of feather), perching mechanism of birds; digestive system, respiratory system, circulatory system, excretory system, and reproductive system].

Seminar/assignments topics : Earth's magnetic field detection and bird migration; eye sight in predatory birds; colour perception capacity of birds; synsacrum in birds.

MODULE 6. [9 hrs]

CLASS: MAMMALIA

Classification of class Mammalia down to the orders cited with examples specified.

Subclass Prototheria

Infraclass Ornithodelphia [egg-laying mammals]

1. Order Monotrematae. e.g. Ornithorhynchus [Platypus], Tachyglossus [= Echidna]

Subclass Theria

Infraclass Metatheria [marsupials]

2. Order Marsupialia. e.g. Didelphis [Opossum], Macropus [Kangaroo]

Infraclass Eutheria [true placental mammals]

3. Order Edentata. e.g. Bradypus (Sloth), Dasypus (Armadillo) Myrmecophaga (Spiny ant-eater)

4. Order Pholidota e.g. Manis (Pangolin/ Scaly ant-eater)

5. Order Lagomorpha [rabbits and hares] e.g. Lepus nigricollis (Indian Hare)

6. Order Rodentia e.g. Funambulus, Ratufa (Giant squirrel)

7. Order Soricimorpha [shrews, moles] e.g. Suncus murinus, Crocidura

8. Order Erinaceomorpha. e.g. *Paraechinus micropus* (Indian Hedgehog)

9. Order Chrysochloridae. e.g. Golden mole of South Africa

10. Order Dermoptera [colugos] e.g. *Cynocephalus volans* (flying lemur)

11. Order Chiroptera. e.g. Pteropus, Pipistrellus, Kerivoulapicta (Painted bat)

12. Order Primates e.g. Tarsier, Lemur, Loris, Macaca, Gorilla, Pongo, Hylobates, Homo

13. Order Carnivora e.g. Phoca (Seal), Odobenus (Walrus), Panthera sp., Viverricula indica (Civet), *Lutrogale* (Otter), *Cuon alpinus* (Wild dog).

14. Order Cetacea e.g. Physeter (Sperm whale), Delphinus (Dolphins),

15. Order Artiodactylae. e.g. *Sus scrofa cristatus* (Wild Boar), *Bos gaurus* (Gaur), *Giraffa* (Giraffe), *Hemitragus* [Tahr], *Rusa (=Cervus) unicolor* (Sambar deer), *Axis axis* (Spotted deer), *Moschiola* (Mouse deer), *Antelope cervicapra* (Blackbuck).

16. Order Perissodactylae. e.g. *Equus caballus* (Horse), Rhinoceros

17. Order Sirenia e.g. *Trichechus* (Manatee), Dugong

18. Order Proboscidea e.g. *Elephas maximus indicus* [Indian elephant], *Elephas maximus*, *Loxodonta africana* [African savanna elephant] and *Loxodonta cyclotis* [African forest elephant].

19. Order Hyracoidea. e.g. Hyrax (Coney)

20. Order Tubulidentata e.g. Aardvark

Seminar/assignments topics (Brief details) : Haplorhines and Strepsirhines (wetnosed and dry nosed monkeys); new world monkeys and old world monkeys ; lesser and greater apes ; colour perception capacity of primates

Type: *Oryctolagus cuniculus* (European Rabbit)

[External features, digestive system, respiratory system, circulatory system, excretory system, reproductive system].

MODULE 7. [4 Hrs]

Comparative Anatomy

Compare the Digestive, circulatory, excretory and nervous systems of vertebrates.

REFERENCES

- Areste, M. & Cebrian, R. (2003). Snakes of the World. Sterling Publishing Company, New York.
- Barbour, T. (1926). Reptiles and Amphibians-Their Habits and Adaptations. Houghton Mifflin Co., New York.
- Burnie, D. & Wilson, D. E. (2001). Animal. Dorling-Kindersley, London.
- Chanda, S. K. (2002). Handbook - Indian Amphibians. Zoological Survey of India, Kolkata.
- Colbert, E. H. (1980). Evolution of the Vertebrates: A History of the Backboned Animal through Time, 3rd Edition. J. Wiley & Sons, Wiley - Interscience Publication, New Jersey.
- Das, I. (2002). A Photographic Guide to Snakes and Other Reptiles of India. Ralph Curtis Books, Florida.
- Daniel, J. C. (2002). The Book of Indian Reptiles and Amphibians. Oxford University Press & Bombay Natural History Society, Mumbai.
- Daniels, R. J. R. (2005). Amphibians of Peninsular India. Indian Academy of Sciences & Universities Press, Hyderabad.
- Daniels, R. J. R. (2002). Freshwater Fishes of Peninsular India. Indian Academy of Sciences & Universities Press, Hyderabad.
- Day, F. (1971). The Fishes of India: Being a Natural History of the Fishes Known to Inhabit the Seas and Fresh Waters of India, Burma, and Ceylon. Volume I & II. MJP Publishers, Chennai
- Dhami, P. S. & Dhami, J. K. (2009). Chordate Zoology. R. Chand & Co., New Delhi.
- Ekambaranatha Ayyar, M. & Ananthakrishnan, T. N. (1985). A Manual of Zoology.

- Volume II Part I & II. S. Viswanathan Pvt. Ltd., Chennai.
- Grewal, B. (2000). Birds of the Indian Subcontinent. Local Colour Ltd, HK.
- Grimmett, R., Inskipp, C. & Inskipp, T. (2011). Birds of the Indian Subcontinent. 2nd Edition. Christopher Helm Publishers, London.
- Groves, C. P. (2001). Primate Taxonomy. Smithsonian Institute, Washington D.C, USA.
- Harvey Pough, F., Janis, C. M. & Heiser, J. B. (2009). Vertebrate Life. 8th illustrated edition. Benjamin Cummings (Pearson Education Inc., Indian Edition).
- Induchoodan (2004). Keralathile Pakshikal (Birds of Kerala). Kerala Sahitya Academy, Trichur.
- Johnsingh, A. J. T. & Manjrekar, N. (2012). Mammals of South Asia - Volume 1 & 2. Orient Black Swan Publishing, Hyderabad.
- Jordan, E. L. & Verma, P. S. (2014). Chordate Zoology. S. Chand & Company Ltd., New Delhi.
- Kardong, K. V. (2014). Vertebrates: Comparative Anatomy, Function and Evolution. McGraw-Hill Higher Education, New York.
- Kent, G. C. & Carr, R. K. (2001). Comparative Anatomy of the Vertebrates, 9th Edition. Tata McGraw-Hill Publishing, New Delhi.
- Kotpal, R. L. (2007). Modern Textbook of Zoology: Vertebrates. Rastogi Publications, Meerut.
- Liem, K. F. (2001). Functional Anatomy of the Vertebrates: An Evolutionary Perspective, 3rd Edition. Harcourt College Publishers, USA.
- McKenna, M. C. & Bell, S. K. (1997). Classification of Mammals: Above the Species Level. Columbia University Press, USA.
- Menon, V. (2014). Indian Mammals: A Field Guide. Hachette India, New Delhi.
- Noble, G. K. (1954). The Biology of the Amphibia. Dover Publications Inc., New York.
- Pande, S. (2003). Birds of Western Ghats, Kokan & Malabar: Including Birds of Goa. Bombay Natural History Society, Mumbai.
- Prater, S. H. (1971). The Book of Indian Animals. Bombay Natural History Society, Mumbai.

Salim Ali (1969). Birds of Kerala. 2nd Edition. Oxford University Press, New Delhi.

Salim Ali (1997). The Book of Indian Birds. 12th Edition. Bombay Natural History Society &

Oxford University Press.

Walter, H. E. & Sayles, L. P. (1949). Biology of the Vertebrates: A Comparative Study of Man and His Animal Allies. 3rd Edition. MacMillan & Company, New York.

Wilson, D. E. & Reeder, D. M. (2005). Mammal Species of the World: A Taxonomic and Geographic Reference, Volume 1. Johns Hopkins University Press, USA.

Whitaker, R. (2006). Common Indian Snakes: A Field Guide. 2nd Edition. MacMillan & Co, India.

Whitaker, R. & Captain, A. (2016). Snakes of India: The Field Guide. Westland/ Draco Books

Young, J. Z. & Nixon, M. (1981). Life of Vertebrates. Oxford University Press, New York.

Young, J. Z. (1958). Life of Mammals. Oxford University Press, New York.

CORE COURSE PRACTICALS II

ANIMAL DIVERSITY: CHORDATA

No. of Credits-2

Total hours 36

Course outcomes:

- *Achieve practical efficiency in classification of animals*
- *To understand the method of biological specimen preparation and dissections*

MODULE 1. [36 hrs]

Students are expected to make sketches with notes, while they study the specimens in the laboratory/field itself. The record must carry sketches with notes of all specimens, mountings and dissections. Emphasis must be on scientific accuracy and not on beauty of sketches. Study of the following chordate specimens: (All animals intended for type study are to be included. Slides / museum preparations are to be used; charts / model/ Photographs/videos may be used in exceptional cases. Students are expected to identify the specimens by their generic names and assign them to the respective phyla and classes).

Section A. Study of the following Chordate specimens:

(Students are expected to identify the specimens by their generic names and assign them to the respective phyla /classes/ orders)

1. Urochordates : *Ascidia*, ascidian tadpole [any 1]

2. Cephalochordates : *Branchiostoma*

3. Agnathans : *Myxine*, *Petromyzon* [any 1]

4. Fishes :

a. Common elasmobranchs - *Chiloscyllium*, *Stegostoma*, *Sphyrna*, *Pristis*, *Trygon*, *Narcine*, *Astrapes* [any 2]

b. Common edible fishes (marine) - *Sardinella*, *Rastrelliger*, *Cynoglossus*, *Parastromateus*, *Trichiurus*, *Cybius*, *Thunnus* [any 2]

c. Common edible fishes (Inland) - *Etroplus*, *Mugil*, *Wallagonia*, *Tilapia*, *Catla*, *Cirrhina*, *Labeo*, *Cyprinus* [any 2]

d. Fishes with special adaptive features - *Hippocampus*, *Belone*, *Hemiramphus*, *Exocoetus*, *Tetraodon*, *Pterois*, *Ostracion*, *Heteropneustes*, *Clarias*, *Arius*, *Anabas*, *Channa*, *Echeneis*, *Antennarius*, *Amphisila*, *Anguilla* [any 3]

5. Amphibians: Common amphibians - *Duttaphrynus*, *Euphlyctis*, *Rhacophorus*, *Ambystoma*, *Axolotl larva*, *Ichthyophis/Uraeotyphlus* [any 2]

6. Reptiles : colour images

a. Common lizard - *Hemidactylus*, *Calotes*, *Mabuya* (*Eutropis*) [any 1]

b. Lizards with special adaptations - *Draco*, *Chamaeleo*, *Phrynosoma* [any 1]

c. Non venomous snakes - *Ptyas*, *Gongylophis*, *Lycodon*, *Indotyphlops* [any 1]

d. Venomous snakes - *Naja*, *Daboia*, *Bungarus*, *Echis* [any 1]

e. Water snake - *Hydrophis* / *Enhydris* / *Xenochrophis* [any 1]

f. Arboreal snake - *Dendrelaphis* / *Python* / *Ahaetulla* [any 1]

7. Key for identification of venomous and non-venomous snakes.

8. field visit and Local Biodiversity Record: Observe fishes/amphibians/Reptiles/ Birds/ or any other vertebrate group (any two groups) of the locality in their natural habitat and prepare a fieldnotes and photograph with GPS

9. Observe Fishes/ amphibians/Reptiles/ Birds/Mammals in national/state depositaries or museums like ZSI, CMFRI etc. and prepare a note about 2 species from each group with images of the specimens observed. Endemics to the Western Ghats should be of special interest.

Section B. Histology

1. Branchiostoma - T. S. through pharyngeal region

Section C. Mountings

1. Sardine: Cycloid scale [Minor]

2. Shark: Placoid scale [Minor]

Section D. Dissections (Digital versions to be downloaded or procured as per UGC guidelines)

1. Mullet/ Sardine: Alimentary canal (Major)
2. Shark: IX and X cranial nerves on one side (Major) – Demonstration only.
3. Frog/Calotes: Arterial system (demonstration only).

Section E. Osteology

1. Frog: Typical, 8th, 9th Vertebrae,
2. Frog: Pectoral & Pelvic girdles
3. Snake Vertebra [show Zygosphenes and Zygandrum]
4. Carapace and plastron of turtle/tortoise
5. Bird Synsacrum

Integrated M.Sc Bioscience syllabus

Semester II

Botany core course

ANGIOSPERM MORPHOLOGY AND SYSTEMATICS, PLANT UTILITY & PLANT PHYSIOLOGY

Course code: IBIO2B04

Course Outcomes

1. Understanding the structure of angiosperm flower in relation to their function and evolution.
2. Understanding the historical events in the evolution of flowering plants.
3. Development of skill in description, identification, scientific naming and classification of flowering plants.
4. Recognition of locally available flowering plants and their economic utilities.
5. Appreciation of the importance of traditional knowledge and their documentation.
6. A preliminary understanding of the basic functions in a plant body.
7. Awareness on the interdisciplinary nature of botany, chemistry and physics by studying the principles of plant life, growth and reproduction.
8. Recognizing the wonderful mechanism of transport and the Interrelationships existing between metabolic pathways, thereby gaining an idea about the importance of plants in the dynamicity of nature.

MORPHOLOGY

Definition, Salient features and Parts of the Flower: Bract, Calyx, Corolla, Androecium, Gynoecium. Floral arrangement - types. Relative position, cohesion, adhesion, Symmetry of flower. Aestivation types.

Inflorescence: Racemose, Cymose, Special type and Mixed types. Flower a modified shoot. Placentation types. Floral diagram and floral formula.

A general outline on the origin and evolution of flower and floral parts. Evolutionary trends in pollination mechanisms; origin of flowers vis-à-vis pollinators.

SYSTEMATICS

1. Objectives and relevance of Systematics.
2. Systems of classification: Artificial, Natural and Phylogenetic; brief account of Linnaeus', Engler and Prantl's system and APGsystem. A detailed study of Bentham & Hooker's system- Merits and demerits.
3. International Code of Nomenclature for algae, fungi and plants (ICN) - Latest code –Ranks of taxa - Type concept - Rule of priority - Author citation (brief account only).
4. Plant identification: Taxonomic literatures - Floras, Monograph.
5. Herbaria - Technique of Herbarium. Importance of Herbaria, Important Herbaria.
6. Botanical gardens – their role - important botanical gardens.
7. Taxonomic keys - dichotomous.
8. Plant descriptions – common terminologies used for description of vegetative and reproductive parts.
9. Study of the diagnostic features and economic importance of Angiosperm families: Annonaceae, Nymphaeaceae, Malvaceae, Rutaceae, Leguminosae, Cucurbitaceae, Apiaceae, Rubiaceae, Asteraceae, Apocynaceae, Solanaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Zingiberaceae, Liliaceae, Arecaceae and Poaceae.

PLANT UTILITY

Study of the Botanical name, Family, Morphology of useful parts and Utility of the following: Cereals and millets: Rice, Wheat, Maize, Ragi. Pulses: Bengal gram, Black gram, Green gram, Red gram. Fruits & Vegetables: Banana, Jackfruit, Pineapple, Watermelon, Tomato, Brinjal, Pumpkin, Cucumber, Snake gourd, Bitter gourd. Spices and condiments: Cinnamon, Clove, Cardamom, Pepper. Sugar yielding plant: Sugarcane. Tuber crops: Tapioca, *Amorphophallu*, *Colocasia*. Fibre yielding plants: Cotton, Coir, Jute. Dyes: Indigo, Henna. Latex yielding: Para rubber. Oil yielding: Sesame oil, Palm oil, Coconut oil. Beverages: Tea, Coffee. Medicinal

plants: *Phyllanthus amarus*, *Bacopa monnieri*, *Justicia adhatoda*, *Catharanthus roseus*, *Rauwolfia serpentina*, *Ocimum tenuiflorum*.

Ethnobotany: brief account; indigenous uses of plants.

PLANT PHYSIOLOGY

Plant Water relations: Importance of water in plant physiology, Diffusion, DPD, Plasmolysis, Osmosis, Osmotic Pressure, Concept of water potential, Osmotic potential, Turgor pressure, Imbibition.

Mechanism of water absorption - Active and Passive absorption, Pathway of water movement - apoplastic, symplastic and transmembrane pathways.

Transpiration: Types, Mechanism of stomatal transpiration, Significance of transpiration.

Ascent of sap: Mechanism and Theories of ascent of sap - Cohesion Tension Theory.

Nutrition and Metabolism: Mineral Nutrition: Essential elements – Macro and Micro nutrients.

Mineral salt absorption: Mechanism of mineral salt absorption, Passive and Active absorption.

Photosynthesis: Photosynthetic pigments, Absorption of light, Fluorescence and Phosphorescence, Photo systems, Quantasomes, Action and Absorption spectra, Red drop and Emerson and Enhancement effect, Mechanism of photosynthesis – Photosynthetic electron transport, Photophosphorylation, Photosynthetic carbon reduction cycle – C₃, C₄, CAM pathways, Photorespiration, RUBISCO. Laws of limiting factor, Factors influencing photosynthesis.

Respiration: Mechanism of respiration, Glycolysis, Fermentation, Citric acid cycle, Terminal oxidation, overall balance sheet, Amphibolic nature of citric acid cycle.

Plant Growth and Movements: Phytohormones: Auxin, Gibberellins, Cytokinin, Abscisic acid and Ethylene – Physiological role, Photoperiodism and Vernalisation, Phytochrome - chemistry and physiological effects. Plant movements: Movements of locomotion, Curvature and Hygroscopic movements. Tropic and nastic movements.

Bioenergetics: Laws of Thermodynamics, High energy compounds and high energy nucleotides- ATP, NADPH, FADH and FMN with emphasis to the structure and function of ATP.

CORE COURSE BOTANY PRACTICALS II
ANGIOSPERM MORPHOLOGY AND SYSTEMATICS, PLANT UTILITY AND PLANT
PHYSIOLOGY

Course code: IBIO2H02

(Plant diversity & angiosperm anatomy & angiosperm morphology and systematics, plant utility and plant physiology)

Credit 3

MORPHOLOGY

1. Identify with note different types of aestivation, Inflorescence, fruits and placentation types.
2. Study of at least two primitive flowers and their parts.

SYSTEMATICS

1. Work out, describe in technical terms and illustrate at least one species of each family mentioned in the syllabus.
2. Conduct field visit of at least three days duration to ecologically important habitats. Prepare and submit a minimum of 20 herbarium specimens.

PLANT UTILITY

1. Identify plants/plant products of economic importance of the plants mentioned in the syllabus; with binomial, family and morphology of useful parts.
2. Survey of ethnobotanical uses of plants.

PHYSIOLOGY

1. Determination of rate of plasmolysis using *Rhoeo* leaf epidermal peelings.
2. Determination of relation between water absorption and transpiration.
3. Extraction and separation of leaf pigments by paper chromatography.
4. Determination of effects of light intensity on photosynthesis by Wilmott's bubbler.
5. Photo morphogenesis in seedlings grown under normal light and darkness.
6. Demonstration of gravitropism using Klinostat.

7. Determination of the rate of transpiration using Ganong's potometer.
8. Kuhne's fermentation experiment.
9. Respirometer experiment.

REFERENCES

1. Datta S C, *Systematic Botany*, 4th Ed, Wiley Eastern Ltd., New Delhi, 1988.
2. Eames A. J. - *Morphology of Angiosperms* - Mc Graw Hill, New York.
3. Heywood - *Plant taxonomy* - Edward Arnold London.
4. Jeffrey, C. (1982). *An Introduction to Plant Taxonomy*. Cambridge University Press, Cambridge
5. Judd, W.S., Campbell, C.S., Kellogg, E.A., Stevens, P.F., Donogue, M.J., 2002. *Plant Systematics: A Phylogenetic approach*, 2nd edition. Sinauer Associates, Inc., USA.
6. Lawrence - *Taxonomy of Vascular Plants* - Oxford & I B H, New Delhi.
7. Naik V.N., *Taxonomy of Angiosperms*, 1991. Tata Mcgraw-Hill Pub. Co. Ltd., New Delhi.
8. Pandey, S. N, and S.P. Misra (2008) - *Taxonomy of Angiosperms*- Ane Books India, New Delhi.
9. Sivarajan V. V - *Introduction to Principles of taxonomy* - Oxford & I B H New Delhi.
10. Takhtajan - *Flowering Plants* - Edinburg, Oliver & Boyd.
11. Pandey, A.K. & S. Kasana 2021. *Plant Systematics*. Jaya Publishing House, Delhi.
12. Baker. H.G. 1970. *Plant and Civilization*, Wadsworth Publishing Company..
13. Cotton, C.M. 1996. *Ethnobotany – Principles and Applications*. Wiley and Sons
14. Jain. S. K. 1981. *Glimpses of Indian Economic Botany*. Oxford
15. Jain. S. K. 1995. *A Manual of Ethnobotany*. Scientific Publishers, Jodhpur.
16. Manilal, K.S. and M.S. Muktesh Kumar 1998. *A Handbook on Taxonomy Training*. DST, New Delhi.
17. Manilal, K.S. and A.K. Pandey, 1996. *Taxonomy and Plant Conservation*. C.B.S. Publishers & Distributors, New Delhi.
18. Manilal, K.S. 2003. *Van Rheedee's Hortus Malabaricus. English Edition*, with Annotations and Modern Botanical Nomenclature. (12 Vols.) University of Kerala, Trivandrum.

19. Radford A B, W C Dickison, J M Massey & C R Bell, *Vascular Plant Systematics*, 1974, Harper & Row Publishers, New York.
20. Rajiv K. Sinha 1996 *Ethnobotany The Renaissance of Traditional Herbal Medicine – INA – Shree Publishers, Jaipur.*
21. Shashi S S, 2004. *Tribes of Kerala*, Anmol Publications Pvt Limited
22. Singh G.2012. *Plant systematics: Theory and Practice*. Oxford and IBH, Pvt. Ltd., New Delhi.
23. Singh V. & Jain - *Taxonomy of Angiosperms* - Rastogi Publications, Meerut.
24. Vashishta P. C - *Taxonomy of Angiosperms* –S.Chand & Co, Meerut.
25. Vasudevan Nair, R - *Taxonomy of Angiosperms* - APH Pub: New Delhi
26. Venkateswaralu, V. - *Morphology of Angiosperms* - Chand & Co.
27. Verma R. C., 2002, *Indian Tribes through the ages*, Publication Division, Govt. Of India.
28. Viswanathan Nair, N.,1969, *Tribal health and medicine in Kerala*, D C Books.
29. Bajracharya, D., 1999. *Experiments in Plant Physiology - A Laboratory Manual*. Narosa Publishing House, New Delhi.
30. Frank B. Salisbury, Cleone W Ross, 1999. *Plant Physiology*. 3rd edition.CBS Publishers and Distributers, Delhi.
31. Srivastava, H. S. 1998. *Plant Physiology*. Rastogi publications, Meerut.
32. Hopkins, W.G., Huner, N.P., (2009). *Introduction to Plant Physiology*. John Wiley & Sons, U.S.A. 4th Edition.
33. Lincoln Taiz and Eduardo Zeiger, 2003. *Plant Physiology (III Edn)*. Panima publishing Corporation, New Delhi.
34. Pandey, S N., B K Sinha, 2006. *Plant Physiology*. Vikas Publishing House Pvt. Ltd
35. Taiz, L., Zeiger, E., 2010. *Plant Physiology*. Sinauer Associates Inc., U.S.A. 5th Edition.
36. Verma V. 2007. *Textbook of Plant Physiology*. Ane Books India, New Delhi.