



Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with A++ Grade by NAAC, CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

Department of Zoology

B.Sc. Zoology

Programme Outcomes

1. Attain and apply fundamental knowledge in basic concepts of Science
2. Gain Competence to communicate effectively
3. Develop critical thinking for innovations
4. Identify problems and suggest appropriate scientific, technological and environmental solutions.
5. Function individually or as a team in work environment
6. Acquire research skills to inquire, synthesize and articulate solution for community development.
7. Create and apply ICT tools for learning and technology development
8. Exhibit professional ethics and norms for social development
9. Implement acquired knowledge in basic sciences for self directed and lifelong learning
10. Promote entrepreneurial skills

Programme Specific Outcomes

1. Have a comprehensive knowledge to identify and to know the origin, ancestry and ecological adaptations of animals.
2. Attain a wide knowledge on the cellular and genomic level of organization, embryonic development and reproduction in animals.
3. Augmentation of acquired skills and application of knowledge for research and academic sustainability.

Scheme of Instruction & Examinations (for students admitted from 2023-2024 & onwards)

(for students admitted from 2023-2024& onwards)									
Part	Subject Code	Name of paper / Component	Hours of instruction/ week	Scheme Examination					
				Duration of exam	CIA	CE	Total	Credit	
First Semester									
I	23BLT001/ 23BLH001/ 23BLF001	பொதுத்தமிழ்தாள் I-இக்கால இலக்கியம் / Prose and Non Detailed Texts/ French I	2	3	50	50	100	2	
II	23BAEEC1	Ability Enhancement Compulsory Course - I English for Communication	4	3	50	50	100	4	
II	Generic Elective								
		Generic Elective - I	5+1/4+4	3	50	50	100	6	
III	Discipline Specific Core Courses								
	23BZOC01	Systematics and Diversity of Life Protists to Chordates	4	3	50	50	100	4	6
	23BZOC01P	Practicals I - Systematics and Diversity of Life Protists to Chordates	4	3	50	50	100	2	
	23BZOC02	Developmental Biology & Evolution	4	3	50	50	100	4	
	23BZOC02P	Practicals II - Developmental Biology & Evolution	4	3	50	50	100	2	
IV	23BVBNC1/ 23BVBNS1/ 23BVBSP1	Skill Enhancement Course Value Based Course Elective I – NCC / NSS / Sports	3/2	2	60	40	100	4/1/1	
		Games – Practical	1		-	-	-		
Total								28/25	

Second Semester									
I.	23BLT002/ 23BLH002/ 23BLF002	பொதுத்தமிழ்தாள் II – அறஇலக்கியம் / Grammar, Translation and General Essay / French II	2	3	50	50	100	2	
II	23BAEES1	Ability Enhancement Compulsory Course - II Environmental Studies	4	3	50	50	100	4	
II	Generic Electives								
	23BENGE2A/ 23BENGE2B/ 23BENGE2C/ 23BENGE2D	Generic Elective - II Introduction to Literature / British Literature / Modern Indian Literature / New Literatures in English	5+1	3	50	50	100	6	
III	Discipline Specific Core Courses								
	23BZOC03	Comparative Anatomy & Physiology of Nonchordates	4	3	50	50	100	4	6
	23BZOC03P	Practicals III - Comparative Anatomy & Physiology of Nonchordates	4	3	50	50	100	2	
	23BZOC04	Cell Biology and Histology	4	3	50	50	100	4	6
	23BZOC04P	Practicals IV - Cell Biology and Histology	4	3	50	50	100	2	
IV	23BVBNC2/ 23BVBNS2/ 23BVBSP2	Skill Enhancement Course Value Based Course Elective I – NCC / NSS / Sports	3/2	2	60	40	100	4/1/1	
		Games – Practical	1		-	-	-		
							Total	28/25	
Third Semester									
I	23BLT003/ 23BLH003/ 23BLF003	பொதுத்தமிழ்தாள் III - சமயஇலக்கியம் /Ancient and Modern Poetry / French III	2	3	50	50	100	2	
II	Generic Elective								
		Generic Elective III	5+1/4+4	3	50	50	100	6	
III	Discipline Specific Core Courses								
	23BZOC05	Comparative Anatomy & Physiology of Chordates	4	3	50	50	100	4	6
	23BZOC05P	Practicals V- Comparative Anatomy & Physiology of Chordates	4	3	50	50	100	2	
	23BZOC06	Genetics	4	3	50	50	100	4	6
	23BZOC06P	Practicals VI - Genetics	4	3	50	50	100	2	
Skill Enhancement Courses									
IV	23BSBCS1	Skill Based Compulsory Course – I Communication Skill	4P	3	50	50	100	2	
		Skill Based Elective Course – II	4P	3	50	50	100	2	
	23BVBNC3/ 23BVBNS3/ 23BVBSP3	Value Based Course Elective I – NCC / NSS / Sports	3/2	2	60	40	100	4/1/1	
		Value Based Course Elective II	2	-	100	-	100	2	
							Total	30/27	
Fourth Semester									
I	23BLT004/ 23BLH004/ 23BLF004	பொதுத்தமிழ்தாள் IV - சங்கஇலக்கியம் / Introduction to Functional Hindi and Journalism /	2	3	50	50	100	2	

		French IV							
II	Generic Elective								
		Generic Elective IV	5+1/4+4	3	50	50	100	6	
III	Discipline Specific Core Courses								
	23BZOC07	Biochemistry	4	3	50	50	100	4	6
	23BZOC07P	Practicals VII - Biochemistry	4	3	50	50	100	2	
	23BZOC08	Ecology	4	3	50	50	100	4	6
	23BZOC08P	Practicals VIII – Ecology	4	3	50	50	100	2	
IV	Skill Enhancement Courses								
	23BSBSS1	Skill Based Compulsory Course – III Soft skill	4P	3	50	50	100	2	
		Skill Based Elective Course – IV	4P	3	50	50	100	2	
	23BVBNC4/ 23BVBNS4/ 23BVBSP4	Value Based Course Elective I – NCC / NSS / Sports	3/2	2	60	40	100	4/1/1	
		Value Based Course Elective III	2	-	100	-	100	2	
Total								30/27	
Fifth Semester									
III	Discipline Specific Core Courses								
	23BZOC09	Molecular Biology	4	3	50	50	100	4	6
	23BZOC09P	Practicals IX- Molecular Biology	4	3	50	50	100	2	
	23BZOC10	Biotechniques	4	3	50	50	100	4	6
	23BZOC10P	Practicals X- Biotechniques	4	3	50	50	100	2	
	Discipline Specific Elective Courses								
	23BZODE1	DSE - I Project/Internship	4	3	50	50	100	6	
	23BZODE2 - 23BZODE9	DSE - II Theory + Practical	4+4	3	50	50	100	6	
Skill Enhancement Courses									
IV	23BVBNC5/ 23BVBNS5/ 23BVBSP5	Value Based Course Elective I – NCC / NSS / Sports	3/2	2	60	40	100	4/1/1	
Total								28/25	
Sixth Semester									
III	Discipline Specific Core Courses								
	23BZOC11	Microbiology, Parasitology and Immunology	4	3	50	50	100	4	6
	23BZOC11P	Practicals XI - Microbiology, Parasitology and Immunology	4	3	50	50	100	2	
	23BZOC12	Applied Zoology	4	3	50	50	100	4	6
	23BZOC12P	Practicals XII - Applied Zoology	4	3	50	50	100	2	
	Discipline Specific Elective Courses								
	23BZODE2 - 23BZODE9	DSE - III Theory + Practical	4+4	3	50	50	100	6	
	Discipline Specific Elective Courses								
	23BZODE2 - 23BZODE9	DSE - IV Theory + Practical	4+4	3	50	50	100	6	
Skill Enhancement Courses									
IV	23BVBNC6/ 23BVBNS6/ 23BVBSP6	Value Based Course Elective I– NCC / NSS / Sports	3/2	2	60	40	100	4/1/1	
Total								28/25	
Over all total								172/154	

- **Skill Enhancement courses**, are Skill Based and / or Value Based which are aimed at providing hands on training, competencies, skills etc. and may be opted by the students from the electives offered by the departments or from SWAYAM MOOCs / NPTEL

Skill Based courses

- **Skill Based Compulsory course I** – 23BSBCS1 – Communication Skill during 3rd semester
- **Skill Based Compulsory course III** - 23BSBSS1 – Soft Skill during 4th semester

- **Skill Based courses offered by Zoology department**

S. No	Skill Based Elective courses (II/ IV)	Semester	Hours of Instruction	Credit/Course
1.	23BZOSE1- Beekeeping	3	4P	2
2.	23BZOSE2- Aquaculture	4	4P	2
3.	23BZOSE3-Vermicomposting	4	4P	2

- **Value Based Courses - Elective I**

Value Based Courses Elective I	Subject Code	Semester	No of .Credits
NCC/ NSS/ Sports	23BVBNC1-6/	1-6	24 Credits
	23BVBNS1-6/		6 Credits
	23BVBSP1-6		6 Credits

- **Value Based Courses - Elective II/ III offered by Zoology department**

Value Based Courses Elective II /III	Subject Code	Semester	Hours of Instruction	Credit / Course
Nil				

- **Discipline Specific Elective Courses** should be related to their own core which may be from SWAYAM MOOCs /NPTEL also

S.No.	DSE Courses	Semester	Hours of Instruction	Credits
			Theory + Practical	
1.	23BZODE1 - Project / Internship	5	4	6
2.	23BZODE2 - Endocrinology	5 / 6	4+4	6
3.	23BZODE3 - Mammalian Physiology	5 / 6	4+4	6
4.	23BZODE4 - Human Reproductive Biology	5 / 6	4+4	6
5.	23BZODE5 - Genetic Engineering and Biotechnology	5 / 6	4+4	6
6.	23BZODE6 - Agrochemicals and Pest Management	5 / 6	4+4	6
7.	23BZODE7 - Wildlife Conservation and Management	5 / 6	4+4	6
8.	23BZODE8- Aquatic Zoology	5 / 6	4+4	6
9.	23BZODE9 - Livestock Management and Animal Husbandry	5 / 6	4+4	6

- **Generic Elective Courses** offered for other disciplines / departments

- A Core Course offered in a Discipline / Subject may be offered as a Generic Elective for other departments.

S.No	Generic Elective Courses	Semester	Hours of Instruction	Credits
			Theory + Practical	
1.	23BZOG1 - Human Physiology	1,3,4	4+4	6
2.	23BZOG2 - Food, Nutrition and Health	1,3,4	4+4	6

Total credits to earn the degree

1. Part I components - 8 Credits (Languages)
2. Part II components - 32 Credits [Ability Enhancement Compulsory courses Courses- 8 Credits and Generic Elective Courses - 24 Credits]
3. Part III components - 96 Credits (Discipline Specific Core Courses - 72 Credits and Discipline Specific Elective Courses - 24 Credits)
4. Part IV components - 36 /18 Credits (Skill Enhancement Courses - Skill Based Courses - 8 Credits, Value Based Courses Elective I (NCC/NSS/Sports) -24 / 6 / 6, Value Based Courses Electives II & III - 4 Credits)
5. Minimum one course should be from SWAYAM MOOCs/ NPTEL.

One to 4 Courses may be from SWAYAM MOOCs/NPTEL for Credit Transfer in DSE, Generic Elective &/or Skill Enhancement Courses

Systematics and Diversity of Life Protists to Chordates

Semester I
23BZOC01

Hours of instruction / week : 4
No of credit: 4

Objectives

1. To study the biosystematics classification of animals.
2. To learn the salient features and diversity of invertebrates and vertebrates
3. To understand the evolutionary significance of chordates

Unit 1: Products of evolutionary process

12 hrs

Multicellularity: from simple collections of poorly differentiated cells to complex body plans. Biological diversity- Types and measurements. Systematics and taxonomy. Species concept, clades. Nomenclature and utility of scientific names. Classification based on morphology and evolution (molecular). Relationship of taxa: phylogenetics and cladistics with special reference to paraphyly, monophyly, apomorphy, plesiomorphy and phenoplasticity.

Unit 2: Diversity in Protists and acoelomate Metazoa

12 hrs

Structure and diversity in Protists. Origin of Metazoans: Diploblastic and triploblastic organization; symmetry, body cavities, protostomes and deuterostomes, Special features and structural diversity in sponges. Cnidarians: Special features; transition of third germ layer; polymorphism and division of labour; coral reef forming Cnidarians. The Bilateria: Basic characteristics. The acoelomates: Basic organization and adaptive radiations in flatworms.

Unit 3: Diversity in pseudocoelomate and coelomate Nonchordates

12 hrs

The Ecdysozoa: Characteristics of the representative taxa. Pseudo coelomates; Basic organization and adaptive radiations in roundworms. The coelomates: Basic organization and adaptive radiations in Arthropods. Ancestors/ fossil arthropods. Adaptive radiations in Crustaceans, Myriapods, Chelicerates, Insects, etc. Basic organization and diversity in Annelids, Basic organization and diversity in Molluscs. Disruption of bilateral symmetry and its significance. Basic organization of Echinoderm, their affinity to Chordates.

Unit 4: Diversity in Protochordates and Chordates

12 hrs

Chordates – Primitive Chordates and their affinities. Hemichordates, Urochordates and Cephalochordates. Advent of vertebrates: Cyclostomes, their evolutionary status and affinities. Basic organization and diversity of fishes, their evolutionary transitions. From Water to Land invasion - Early Tetrapodes. Amphibians diversity and adaptability to dual mode of life.

Unit 5: Amniotes: the amniotic egg, adaptive radiations in reptiles; Poisonous and non poisonous snakes of South India, identification of poisonous snakes, poison apparatus and biting mechanisms. The avian ancestors. Birds: Adaptation from terrestrial to aerial mode of life. Origin of Mammals Special features of Monotremes and Marsupials. Characteristics of other mammalian groups with special reference to primates

Total – 60 hrs

Text Books:

1. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
2. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
3. Barnes, R. S. K.; Calow, P.; Olive, P. J. W.; Golding, D. W; Spicer, J. I. (2002). The Invertebrates: a Synthesis, Blackwell Publishing.
4. Kardong, K.V. (2006) Vertebrates: Comparative Anatomy, Function, Evolution (4th edition), McGraw-Hill.
5. Kotpal, R.L. 2015. Modern Text Book of Zoology – Vertebrates. Meerut: Rastogi Publications.

Reference Books:

1. Liem, Karel F., William E. Bemis, Warren F. Walker, Lance Grande, 2001. Functional Anatomy of the Vertebrates: An Evolutionary Perspective. Brooks Cole; 784 pages.
2. Holland, P. (2011) The Animal Kingdom: A Very Short Introduction, Oxford University Press.
3. Eisenhour, David, Allan Larson, Susan Keen, Larry Roberts, Cleveland Hickman Jr. 2014. Animal Diversity. Boston: McGraw-Hill International.
4. Kotpal, R.L. 2017. A Text Book of Animal Diversity. Meerut: Rastogi Publications.
5. Hickman, C.; Roberts, L.S.; Keen, S.L.; Larson, A. and Eisenhour, D. (2018) Animal Diversity, McGraw-Hill.

Course Outcomes:

1. Develop understanding on the diversity of protists, non chordates and chordates.
2. Understanding the concepts of how animals changed from a primitive cell to simple cells.
3. Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
4. Understand the role of morphological changes in bringing out the evolution over a long period of time.
5. Acquire skill in identification of invertebrate and vertebrates in their habitats.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	H	M	-	M	H	-	H	H	H	-	H
CO 2	-	-	M	H	-	-	H	-	L	-	-	-	H
CO 3	H	M	H	M	-	L	H	M	H	L	H	-	H
CO 4	M	L	-	-	-	-	M	M	H	M	H	-	M
CO 5	H	-	H	H	H	H	H	H	H	H	H	-	H

Practicals I- Systematics and Diversity of Life Protists to Chordates

Semester I
23BZOC01P

Hours of instruction / week : 4
No of credit : 2

Objectives:

1. To identify and classify museum specimens and to study their salient features.
2. To develop skills in stimulated dissections.
3. To observe and compare the diversity of animals in their natural habitat.

1. Study of animal through slides and museum specimens in the laboratory with details on their classification, biogeography and diagnostic features (record book).

Invertebrate Simulated animal dissections available on invertebrates

12 hrs

Representative organisms for each phylum

- I. Amoeba, Paramecium
- II. Leucosolenia, Gemmule of Sponge
- III. Hydra, Obelia colony and medusa
- IV. Fasciola, Ascaris,
- V. Neries, Megasclex
- VI. Daphnia, Naupilus
- VII. Fresh water mussel, Pila
- VIII. Starfish, Sea urchin,

Vertebrates Simulated animal dissections of shark and frog

8 hrs

Representative organisms for each Phylum

- I. Amphioxus, Scoliodon
- II. Ranahexadactyla, Ichthyophis
- III. Calotes, Cobra
- IV. Pigeon, Woodpecker
- V. Bat, Loris

2. Study of animals in nature during a survey of a National Park or Forest area.

8 hrs

Visit to Gass Museum
Visit to Anamalai Tiger Reserve
Visit to Zoological Park/ National Park

3. Collection of five species (preferably invertebrates, insects) belonging to a clade. A project work on 2 their generic identification, description and illustration with a note on their locality. Also the assessment of their relationship by constructing a cladogram using characters and character states- Insect box preparation

8 hrs

4. Comparison of two species of birds belonging to same genus (Inter specific difference)

8 hrs

5. Comparison and weighting of characters of two birds belonging to same family but dissimilar genera.

8hrs

6. Group discussion or Seminar presentation on one or two related topics from the list

8 hrs

1. Molecular systematic Vs Traditional Taxonomy
2. Instinctive behavior invertebrates
3. Parental care of animals

Total - 60

Course Outcome:

1. Study the behaviours of invertebrate through simulated animal dissections.
2. Providing with the ability to recognize the major groups of invertebrates and vertebrates
3. Record the fauna of different phylum and families through the visit to National park and forest area.
4. Collection and contribution of animal specimens to department museum through field visit.
5. Learn the keys for the identification of bird watching through field visits.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	L	L	H	H	H	-	H	M	L
CO 2	H	H	H	H	M	H	H	H	H	-	H	M	L
CO 3	H	H	H	M	H	M	M	M	L	-	H	M	L
CO 4	H	H	H	M	M	H	M	H	M	-	M	M	L
CO 5	H	H	H	M	H	H	M	M	L	-	M	M	M

Developmental Biology & Evolution

Semester I
23BZOC02

Hours of instruction / week: 4
No of credit: 4

Objectives:

1. To learn the basic principles of growth and development
2. To understand the role and application of developmental biology
3. To know about the evolutionary history of transitions

- Unit 1. Process of reproduction in living system** 13hrs
- Reproduction: a basis of species sustenance. Asexual and sexual reproduction and their relevance in corresponding environments. Gamete formation, external and internal fertilization; causes of Infertility. Structural and biochemical changes in gametes during and after fertilization, block to polyspermy. Establishment of the major embryonic axes, polarity, morphogen gradients and their interpretation. Fate maps, their relevance. *In vitro* fertilization; Amniocentesis; Artificial insemination (AI); Gamete intra-fallopian transfer (GIFT). Intra-cytoplasmic sperm injection (ICSI); Test tube baby.
- Unit 2. Role of development in organization of phenotypes and their variations** 12hrs
- Direct and indirect development. Cleavage: types and patterns. Body plan and symmetries. Germ layer differentiation Tubulation. Morphogenesis: Epiboly, emboly/ invagination, involution and ingression. Cell-cell interactions (cell signaling, cell adhesion etc.) during tissue organization, lateral inhibition, induction, and recruitment. Organogenesis: formation of gut, heart, kidney and muscles. Concept of competence, determination and differentiation and growth, molecular mechanism involved. Pleuropotency. Stem cell biology and tissue repair.
- Unit 3. Tracing the evolutionary biology of development** 12 hrs
- Role of extra embryonic membranes in development, Placenta: types, structure and functions. Metamorphosis in insect and frog. Regeneration: epimorphosis, morphollaxis and compensatory regeneration. Development, ageing and apoptosis. Developmental biology in understanding of disorders. Teratogenesis; wound healing, birth defects, developmental brain disorders.
- Unit 4. Understanding evolution through natural selection.** 12hrs
- Early life on Earth and its indirect evidences, direct evidence of early life; great oxygenation and its relationship with life. Evolution and radiation of metazoans, major evolutionary transitions, Mass extinctions, Anthropocene and its uniqueness. Evidences of evolution: Hardy-Weinberg Equilibrium, Selection, Migration. Nonrandom mating, Cost/benefit of sex, Sexual conflict, Evolution in asexual systems Life-history adaptations, Trade-offs, Number and size of offspring; Parent-offspring conflict.

Unit 5. Knowledge on adaptation and optimal model tradeoffs.

11 hrs

Genetic drift, Neutral evolution; Theories of evolution. Linkage disequilibrium; Epistasis. Heritability; Breeding value. Sources of variation: mutation, recombination, epigenetic variation. Evolution of mutation rates. Phenotypic plasticity, Genome evolution: Mobile genetic elements; gene duplication. Evolution and Health: Evolution of antibiotic Resistance, Virulence, Evolutionary medicine.

Total - 60**Text Books**

1. VishramSing, 2020. Text book of Clinical Embryology, 2nd Updated edition, Elsevier India, Elsevier Health Science.
2. Morgan. TH. 2010. Embryology and Genetics. Agro House Behind Nasrani Cinema. 4th edition, Jodhpur
3. Verma, P.S and Agarwal, V.K. 2016 Chordate Embryology (Developmental biology). Generic (1).

Reference Books

1. Gerhart, J. *et al.* 1997. Cells, Embryos and Evolution. Blackwell Science
2. Baressi, M.J.F and Gilbert, S.F. 2019. Developmental Biology (12th edition). Sinauer Associates is an imprint of Oxford University Press.
3. Wolpert, L. 2015. Principles of Developmental Biology (5th edition). Oxford University Press
4. Campbell, N. and Reece, J. 2014 Biology (10th edition). Benjamin Cummings
5. Charles Darwin, 2021. The Origin of Species. (1 may Deluxe Hard bound 2021 edition finger print publishing.
6. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. 2007. *Evolution*. Cold Spring, Harbour Laboratory Press.
7. Hall, B. K. and Hallgrímsson, B. 2008. *Evolution*. IV Edition. Jones and Bartlett Publishers

Course outcome:

1. Understand the development from an egg to embryo and adult through cell division, cell differentiation and morphogenesis.
2. Realize the expressions and functions of gene networks in controlling the molecular changes and brings out the variation.
3. Explore the relevance of developmental biology in medicine and related disorders
4. Know the past and present scenario of research in developmental biology and evolution
5. Examine the evolutionary history of the taxa based on developmental affinities

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 2	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 3	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 4	H	H	H	H	-	M	H	-	H	-	H	H	H
CO 5	H	H	H	H	-	M	H	-	H	-	H	H	H

Practicals II - Developmental Biology & Evolution

Semester I
23BZOC02P

Hours of instruction / week:4
No of credit: 2

Objectives:

1. To understand the developmental stages of animal
2. To develop the skill in dissecting and learn the anatomy of internal structure
3. To know the phylogenetic relationship of animal phyla

- | | | |
|-----|---|------|
| 1. | Types of eggs based on quantity and distribution of yolk: Sea urchin, Insect, Frog, Chick. | 6hrs |
| 2. | Comparative study of cleavage patterns in Frog and Amphioxus models. | 6hrs |
| 3. | Morphogenetic movements - Blastulation, Gastrulation in Amphioxus, Frog, Chick- Slides | 6hrs |
| 4. | Mounting of chick embryo developmental stages up to 96 h . | 4hrs |
| 5. | Extra embryonic membranes of chick through (virtual aid). | 4hrs |
| 6. | Understanding the process of development (videos) | 4hrs |
| 7. | Study of adaptive radiations in feet and beak of birds and mouth parts of insects. (TNAU insect Museum and bird watching in their locality) | 6hrs |
| 8. | Understanding embryological evidence of evolution (through charts and videos). | 4hrs |
| 9. | Study of types of fossils. Nautilus, Peripatus & Limulus (through charts and videos and Ariyalur field visit) | 6hrs |
| 10. | Analogy and homology (wings of birds and insects, forelimbs of bat and rabbit) | 4hrs |
| 11. | Serial homology in appendages of <i>Palaemon</i> . | 4hrs |
| 12. | Group discussion or Seminar presentation on one or two related topics from the list | 6hrs |
| | 1. Latest trends in developmental biology | |
| | 2. Metamorphosis of frog | |
| | 3. Relevance of Palaeontology in current scenario | |

Total - 60hrs

Course outcome

1. Know the different stages in the development of animals.
2. Pursue fundamental concept of embryological stages of animals
3. Identify the factors influencing the cleavage patterns and gastrulation in animals
4. Understand the adaptive radiation of animals.
5. Study the evidences of evolution and fossil.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	-	M	H	M	H	-	H	H	M
CO 2	H	H	H	H	-	M	H	M	H	-	H	H	M
CO 3	H	H	H	H	L	M	H	M	H	L	H	H	M
CO 4	H	H	H	H	-	M	H	M	H	-	H	H	M
CO 5	H	H	H	M	-	H	M	H	H	-	H	H	M

Comparative Anatomy & Physiology of Nonchordates

Semester II
23BZOC03
Objectives:

Hours of instruction / week: 4
No of credit: 4

1. To learn the diversity of various system in Nonchordates
2. To study about the evolutionary importance of Nonchordate taxa
3. To know the parasitic adaptations to different taxa

Unit 1:	Diversity of Tegument and Digestive system Basic affinities and differences between prokaryotes and eukaryotes; protists and the non-chordate animals. Symmetry, Coelom development and diversity. Cell membrane in protists and its derivatives. Tegument in non-chordates and its derivatives. Nutrition and feeding modes in protists. Digestive system & feeding mechanism in non-chordates): Process of digestion from food vacuoles to complex digestive organs.	12 hrs
Unit 2:	Diversity of Locomotory, Respiratory and Circulatory systems Locomotion and diversity of locomotory organs in protists and non-chordates, muscle and locomotion, Structure and diversity of skeletal elements in protists and non-chordates. Respiration: diversity of respiratory organs, modes of respiration. Respiratory pigments and oxygen consumption rates of different organisms. Circulation and the diversity of circulatory system.	12 hrs
Unit 3:	Diversity of Excretory, Nervous system and sense organs Excretion (protists): endocytosis, exocytosis; Excretion and diversity of excretory organs in non chordates. Nervous system with special reference to diversity in brain and nerve chord. Neuroendocrine systems, pheromones. Sense organs: Mechanoreceptors and their diversity in different taxa. Sense organs: photoreceptors, chemoreceptors, thigmoreceptors, rheoreceptors and proprioceptors in different taxa. olfaction and sound perception in insects, etc.	12 hrs
Unit 4:	Evolution and characteristics of important Non Chordate taxa Diversity of the reproductive organs and accessory sex organs; modes of reproduction- asexual and sexual reproduction. Metamorphosis. Diversity of larval forms in non-chordates. Organization and affinities in fossils (such as trilobites). Affinities of living fossils, <i>Limulus</i> and <i>Peripatus</i> . Polymorphism and colony formation. in echinoderms. Taxa with special characteristics: Types of canal systems in sponges and their significance. Torsion and detorsion in Mollusca. Components of water vascular system.	12 hrs
Unit 5:	Parasitic adaptation Parasitic adaptations and life cycle patterns in parasites belonging to different taxa and The parasites listed by World Health Organization under preventive programmes - <i>Ascaris lumbricoides</i> , <i>Ancylostoma duodenale</i> , <i>Necator americanus</i> , <i>Trichuris trichiura</i> , <i>Strongyloides stercoralis</i> , <i>Taenia solium</i> , <i>Hymenolepis nana</i> , <i>Entamoeba histolytica</i> , <i>Giardia intestinalis</i> and <i>Cryptosporidium</i> . Structure and diversity of the pest organisms- Paddy pest - <i>Tryporyzaa</i> , Sugarcane pest - <i>Chilo</i> and Stored grain pest - <i>Sitophilus oryzae</i> . Invertebrate model organisms and their importance - <i>Drosophila melanogaster</i> and <i>Caenorhabditis elegans</i> .- morphological structure and significance.	12 hrs

Total - 60hrs

Text Books:

1. Marshall, A.J and Williams, W.D. 1995. Textbook of Zoology- Invertebrates. VII Ed., Vol. I, A.L.T.B.S. Publishers.
2. Boradale, L.A. and Potts, E.A. 1961. Invertebrates: A Manual for the use of Students. Asia Publishing Home.
3. Barrington, E.J.W. (1967) Invertebrate structure and function, Nelson, London.
4. 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.
5. Rastogi V. B. 2015: Invertebrate Zoology. Publisher- Kedar Nath Ram Nath.

Reference Books:

1. G.J. Tortora & N.P. Anagnostakos, 1984. Principles of anatomy and physiology. (Harper & Row Publ., N.Y.). 838 pages.
2. Ruppert and Barnes, R.D. 2006. Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
3. Boston: McGraw-Hill. Jordan, E.L. and P.S. Verma. 2010. Invertebrate Zoology. New Delhi: S. Chand & Co Ltd.
4. Margulis L and Capman MJ. 2010. Kingdoms and Domains: An Illustrated Guide to the Phyla of Life on Earth. (IV Ed.). W.H. Freeman and Company, USA.
5. Kapoor VC. 2019. Theory and Practice of Animal Taxonomy and Biodiversity. (VIII Ed.). Oxford and IBH Publishing
6. Barrington E.J.W. 2021. Invertebrate Structure and Function (II Ed.). Affiliated East-West Press Pvt Ltd.

Course outcomes

1. Able to understand the fundamental principles of systematic.
2. Elucidate the functional significance of associated morphology and behaviour.
3. Understand the physiological mechanisms in diverse organisms.
4. Understand and communicate the evolutionary significance in invertebrates.
5. Explicate research in any aspects of animal physiology in future.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	L	-	M	-	H	H	-	H	M	H	-	H
CO 2	M	-	-	-	-	M	H	-	H	-	M	M	H
CO 3	-	-	-	-	-	L	H	-	H	-	-	-	H
CO 4	H	H	H	M	-	M	H	-	H	L	H	-	H
CO 5	H	H	H	H	M	H	H	H	H	H	H	-	H

Practicals III- Comparative Anatomy & Physiology of Nonchordates

Semester II
23BZOC03P

Hours of instruction / week: 4
No of credit: 2

Objectives:

1. To learn computer aided simulated animal dissection
2. To study the economic importance of invertebrates and model organism.
3. To observe and record the animal behavior in their natural habitats

1. Slides and specimens

- i) Protozoans of agricultural importance- *Euglena* and *Vorticella* 6hrs
- ii) Coral-reef forming Cnidarians- *Lycium glomeratum* and *Diploria labyrinthiformis* (Visit to CMFRI-Central Marine Fisheries Research Institute) 6hrs
- iii) Plant parasitic nematodes- *Meloidogyne incognita* and *Globodera rostochiensis* 6hrs

2. Nematodes used as models in experimental biological research- *Caenorhabditis elegans* 4hrs
3. Virtual Dissection of *Pheretima* to expose circumpharyngeal ganglia 4hrs
4. Dissection of *Periplaneta* to expose the digestive system and mouth parts 6hrs
5. Dissection of *Palaemon* to expose nervous system. 6hrs
6. Study of larval forms: *Planula*, *Trochophore*, *Pluteus*, *Zoea*, *Metazoea*, *Bipinnaria* 4hrs
7. Videos to develop understanding on the animals of different taxa. 6hrs
8. Group discussion or Seminar presentation on one or two related topics from the list 12hrs
 - i. Helminth infection in humans
 - ii. Molluscs of industrial value
 - iii. Prawn culture, a good source of revenue generation

Total 60 hrs

Course outcome:

1. Be familiar with the external morphology of animals through observation of preserved specimens.
2. Acquire basic skills in animal dissections.
3. Able to dissect and examine various organ systems.
4. To understand evolutionary significance through larval forms.
5. Disseminate knowledge through group discussions.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	H	H	H	M	L	H	H	H	L	H	H	H
CO 2	H	H	H	H	L	-	H	H	H	-	H	H	M
CO 3	H	H	H	H	L	-	H	H	H	-	H	H	M
CO 4	H	H	H	H	L	-	H	L	H	-	H	H	M
CO 5	H	H	H	H	L	L	H	L	H	L	H	H	M

Cell Biology and Histology

Semester II
23BZOC04

Hours of instruction / week: 4
No of credit: 4

Objectives:

1. To provide a detailed insight into basic concepts of cellular structure and function.
2. To explore the complex regulatory mechanisms that control cell function.
3. To understand the structural and functional significance of animal tissues

Unit 1. Structure and functions prokaryotic and eukaryotic cells	15 hrs
Introduction: Cell biology, its scope in modern perspective. Cell theory and its modern version and interpretation.	
General structure of prokaryotes and eukaryotes: Extra nuclear cell organelles: Ultrastructure and functions of endoplasmic reticulum, ribosome, Golgi apparatus, lysosome, peroxisomes, Mitochondria, microtubules and microfilaments. Nucleus: size, shape, structure and functions of interphase nucleus. Ultrastructure of nuclear membrane and pore complex. Nucleolus: general organization, chemical composition and functions, nuclear sap/ nuclear matrix	
Unit 2. Cell membrane and transport mechanism	13 hrs
Cell membrane organization: cell membrane: origin, structure, composition and functions. Fluid mosaic model: Lipid Composition, inner and outer leaflets. Structure and functions of membrane proteins: Integral, peripheral and lipid-anchored membrane proteins.	
Modifications of cell membrane and membrane transport: Junctional complexes, membrane receptor modifications: microvilli, desmosomes and plasmodesmata. Cell receptor function - cellular trafficking. Transport across membrane: diffusion and osmosis. Active and passive transport, endocytosis and exocytosis.	
Unit 3. Cell cycle and cell signaling	10 hrs
Cell cycle, cell division- mitosis and meiosis. Cell division check points and their regulation. Mutations in the genes that regulate cell cycle and division and their role in causing cancer. Programmed cell death (Apoptosis). Cell regulation and Cell signaling: Signaling molecules and their receptors. Functions of cell surface receptors. Regulation of signaling pathways.	
Unit 4. Cell culturing techniques	10 hrs
Cell culture: Types of cell culture- monolayer and suspension culture. Types of culture media. Sterilization methods for culture wares and culture media. Maintenance of a cell line and storage of cells. Subcellular fractionation by differential centrifugation. Somatic cell hybridization. Basic characteristics of tissue culture media. Tissue culture and engineering.	
Unit 5. Structural and functional significance of animal tissues	12 hrs
Introduction to tissues: Epithelial tissue: types, structure and characteristics. Basement membrane: structure and characteristics. Connective tissue cells. Structure and function of loose, dense and adipose tissue. Cartilage and bone: classification, and fine structure. Muscular tissue: ultrastructure of smooth, skeletal and cardiac muscles. Types of supporting (glial) cells and their function. Myelin sheath and its formation.	

Total - 60hrs

Text Books:

1. Rastogi, S.C. 2021. Cell and Molecular Biology (Fourth Edition). New Age International Publishers, New Delhi.
2. Vijayakumaran Nair, K. and Jayaprakash, M. 2007. Cell Biology, Genetics and Molecular Biology. Fourth Edition. Academica, Thiruvananthapuram.
3. Ajoy Paul, 2011. Textbook of Cell and Molecular Biology. Third Edition. Books and Allied (P) Ltd, Kolkata.

References Books:

1. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Karp, G., Iwasa, J., Marshall, W. 2015. Cell and Molecular Biology: Concepts and Experiments, 8th Edition. John Wiley & Sons Inc.
3. Darnell, Lodish and Baltimore. 2000. Molecular Cell Biology, Scientific American Publishing Inc.
4. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
5. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington D.C., Sinauer Associates, MA.

Course Outcomes:

1. Have comprehensive knowledge on the functioning of nucleus, extra nuclear organelles and intricate cellular mechanisms.
2. Acquire knowledge of different pathways related to cell signaling and apoptosis.
3. Gain knowledge of how cells function in both healthy and pathological states.
4. Find new avenues of joining research in areas such as genetic engineering of cells, cloning, vaccines development, human fertility programme and organ transplant
5. Understand how tissues are produced from cells in a normal course and malfunctioning which may lead to benign or malignant tumor.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	-	H	L	-	H	-	M	H	L
CO 2	H	M	M	M	-	L	-	-	M	-	M	H	M
CO 3	H	M	L	H	-	M	-	-	M	-	-	H	H
CO 4	M	M	M	H	-	M	L	L	M	L	L	H	H
CO 5	H	L	M	M	-	M	L	-	M	-	-	H	M

Practicals IV- Cell Biology and Histology

Semester II
23BZOC04P

Hours of instruction / week:4
No of credit: 2

Objectives:

1. To be able to perform experiments using the common tools of cell biology, including light microscopy and cellular fractioning
 2. To list the fundamental features of prokaryotic and eukaryotic cells and methods used to examine them
 3. To learn histological techniques for the preparation of permanent stained slides
-
1. Study of prokaryotic and eukaryotic cell types with the help of chart, slide and video 4hrs
 2. Principles of light microscope 2hrs
 3. Separation and identification of sub cellular organelles using ultracentrifugation-online video demo 4 hrs
 4. Homogenization and centrifugation of tissues 4 hrs
 5. Haemolysis 4 hrs
 6. Buccal smear test 4 hrs
 7. Examination of live Paramecium to study streaming movement of cytoplasm 4 hrs
 8. Squash preparation of onion root tip to observe chromosome segregation in mitosis 6hrs
 9. Preparation of chromosome squashes from cockroach testes for the observation of stages of meiosis. 6hrs
 10. Study of types of tissue through permanent slides: epithelial, connective, nervous and muscular tissues 6hrs
 11. Study of histology of tissues by preparing permanent stained slides through microtome. 6hrs
 12. Isolation and estimation of DNA from onion 6hrs
 13. Group discussion or Seminar presentation on one or two related topics from the list 4hrs
 1. Popular cell lines and their importance
 2. Apoptosis
 3. Blood groups and their importance

60 hrs

Course Outcomes:

1. Attain knowledge in the identification of different types of cells
2. Acquire practical skills in cytological experiments that mimic those undertaken in diagnostic and research laboratories
3. Gain knowledge in documentation of appropriate diseases
4. Understand the principle and operation of relevant laboratory equipments
5. Perform experiments using microtome techniques to aid immunohistochemistry

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	L	L	M	-	L	-	L	M	-	-	H	H
CO 2	H	L	L	M	-	M	-	-	M	-	L	H	H
CO 3	L	M	L	L	-	M	M	L	L	-	L	L	M
CO 4	M	-	M	M	-	H	L	-	L	-	L	L	H
CO 5	M	L	M	M	-	H	-	L	M	-	L	H	M

Comparative Anatomy & Physiology of Chordates

Semester III
23BZOC05

Hours of instruction / week: 4

No of credit: 4

Objectives:

1. To explore vertebrate morphology with the aims of understanding major events in the history of vertebrate evolution
2. To understand the behaviour and physiological adaptation in diverse habitats.
3. To learn the biological processes of animal life at organelles, cells, organs, organ systems, and at whole animal level.

Unit 1. Structure and function of integument, skeletal and muscular systems

12 hrs

Structure of integument from fishes to mammals with an account on epidermal and dermal derivatives and their functional significance. Anatomy and physiology of axial and appendicular skeleton. Comparative anatomy of pelvic and pectoral girdles from fishes (cartilaginous and bony) to mammals. Types of muscles, physical properties and ultrastructural organization of skeletal muscle fibres, muscle contraction.

Unit 2. Structure and function of digestive, circulatory and endocrine systems

12hrs

Comparative anatomy of jaw suspension, oral cavity, teeth (dentition mammals). Structure and diversity of alimentary canal and digestive glands in chordates. Biological significance of nutrients- carbohydrates, proteins, fats, vitamins and minerals. Physiology of digestion with special reference to enzymes involved. Evolution of aortic arches and their significance. Visceral arches and their functional significance in vertebrates. Structure and evolution of heart in vertebrates. Functional anatomy of heart, cardiac cycle, cardiac output, Integration of cardiovascular function, electrocardiogram. Composition of blood, blood groups, Mechanism of blood coagulation. Types and functional significance of endocrine glands and hormones

Unit 3. Structure and function of respiratory and excretory systems

12 hrs

Aquatic and terrestrial respiration; transition from water to air breathing. Breathing and gas exchange, gas transport, Hb and O₂ dissociation, BMR. Comparative anatomy and functional significance of lungs in amphibians, reptiles, birds and mammals. Types and development of kidneys and their ducts in anamniotes and amniotes. Nephron- structure, types and their function. Physiology of excretion in vertebrates; urine formation, counter current mechanism, Role of ADH and RAAS in excretion. Mechanisms of osmoregulation in fresh water and marine organisms, stenohalinity and euryhalinity.

Unit 4. Structure and function of nervous system

12hrs

Introduction to central and peripheral nervous systems. Structural and functional evolution of brain and spinal cord in various classes of chordates. Peripheral nervous system- functional significance of somatic and autonomic nervous systems. Structure

and functions of neuron, ionic basis of resting and action potentials, nerve impulse and its transmission, synapse and synaptic transmission, Reflex action

Unit 5. Structure and function of sense organs and reproductive system

12 hrs

Types of sense organs- vision, hearing, taste, smell, and touch in chordates. Mechanism of thermoregulation in homeotherms and poikilotherms. Comparative details of testes and ovaries from fishes to mammals; modes of reproduction; estrous and menstrual cycle, implantation, gestation, parturition, lactation and birth control.

Total – 60 hrs

Text Books:

1. Weichert, C.K. 1970. Anatomy of Chordates (4th edition).
2. Jordan, E. L. and Verma, P. S. 2013. Chordate Zoology (14th edition).
3. Saxena, R. K. and Saxena, S. 2015. Comparative Anatomy of Vertebrates (2nd edition).

Reference books:

1. Vander, A.; Sherman, J. and Luciano, D. 2003. Human Physiology (9th edition).
2. Randall, D. et al. 2002. Eckert Animal Physiology (5th edition) Freeman.
3. Hill, R.W. et al. 2008. Animal Physiology (3rd edition) Sinaur Associates.
4. Guyton, A.C. et al. 2008. Textbook of Medical Physiology (12th edition) W.B. Saunders Co.
5. Withers, P.C. et al. 1992. Comparative Animal Physiology (1st edition) Brooks Cole.

Course outcome:

1. Understand the evolution of vertebrates by integrating its structure, function and development.
2. Have an overview of the evolutionary concepts including homology and homoplasy, and detailed discussions of major organ systems.
3. Understand the abnormal function of animal and human diseases and new methods for treatment.
4. Learn generously the life supporting properties and regulation of biological processes by the endocrine glands in the body from conception to adulthood.
5. Develop an understanding of the related disciplines, such as cell biology, neurophysiology, pharmacology, biochemistry etc.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	H	M	H	M	H	M	H	H	H
CO 2	H	H	H	H	H	H	H	M	H	M	H	H	H
CO 3	H	H	H	H	H	H	H	M	H	M	H	H	H
CO 4	H	H	H	H	H	H	H	M	H	M	H	H	H
CO 5	H	H	H	H	H	H	H	M	H	M	H	H	H

Practicals V- Comparative Anatomy & Physiology of Chordates

Semester III
23BZOC05P

Hours of instruction / week: 4
No of credit: 2

Objectives:

1. To demonstrate the fundamentals of physiological processes
2. To compare the structure of organ system in vertebrates
3. To understand the application of haematological techniques.

1. Temporary mount of external scales in fishes (cycloid, placoid, ganoid, ctenoid). 4 hrs
2. Comparative study of brain with the help of models and charts. 2 hrs
3. Comparative study of urinogenital system with the help of models and charts. 4 hrs
4. Comparative study of heart with the help of models and charts. 4 hrs
5. Mount of weberian ossicles of fish. 4 hrs
6. Study of axial and appendicular skeleton of vertebrates. 4 hrs
7. Estimation of haemoglobin. 4 hrs
8. Preparation of human blood smear 4 hrs
9. Counting of different types of blood cells using haemocytometer. 6 hrs
10. Study of action of salivary amylase. 6 hrs
11. Rate of oxygen uptake in fish. 4 hrs
12. Effect of temperature on opercular movement of fish. 4 hrs
13. Excretory products of animals 4 hrs
14. Slides on histology of endocrine glands 4hrs
 - Adrenal gland
 - Pancreas
 - Pituitary gland
 - Thyroid gland
 - Thymus gland
15. Group discussion or Seminar presentation on one or two related topics 2 hrs
 - Hormonal disorders
 - Parental care in animals
 - Social behaviour in primates

60 hrs

Course outcome

1. Ability to explain physiological processes to accomplish the complex goal of sustaining life
2. Understand the physiological processes at organism, organ system, organ, cell, and at biomolecule level
3. Able to differentiate the different types of scales in fishes
4. Describe the evolution of organ system in chordates
5. Familiarise with the histology of endocrine glands

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 2	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 3	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 4	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 5	H	H	H	H	H	H	H	H	H	H	H	H	H

Genetics

Semester III
23BZOC06

Hours of instruction / week: 4
No of credit: 4

Objectives:

1. To acquire the basic concepts and applied aspects of Genetics
2. To learn the key aspects of expression, regulation, interaction, and recombination of Genes
3. To learn and apply concepts of modern transmission and molecular genetics

Unit 1.	Concept of Genes and Genomics	12 hrs
	Scope and importance of Genetics. Elements of heredity and variation: Classical and Modern concept of Gene (Cistron, muton, recon), Alleles etc. Mendel's laws of inheritance, Chromosomal basis of inheritance and its applications. Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Multiple allelism, Lethal alleles, Pleiotropy, Epistasis - Recessive, Double recessive and double dominant. Genomic imprinting, Penetrance and expressivity, Phenocopy, Polygenic inheritance. Mendelian traits in man.	
Unit 2.	Recombination and interaction of Genes	12hrs
	Linkage and crossing over, cytological basis of crossing over. Organelle inheritance (Mitochondrial) Extra-nuclear inheritance, Maternal Inheritance, Sex Chromosomes and sex linkage: XX/XO, XX/XY, ZZ/ZW and haploidy/diploidy types, Gene dosage Compensation, Epigenetics. Structural and numerical alterations of chromosomes, meiotic consequences in structural heterozygotes. Autosomal dominant and autosomal recessive, X-linked dominant, and X-linked recessive. Haplodiploidy. Genic balance theory, intersex, gynandromorphs. Hormonal influence on sex determination-Freemartin and sex reversal. Role of environmental factors- Bonellia and Crocodile.	
Unit 3.	Regulation of Gene expression, and mapping	12 hrs
	Gene Expressions and regulation: One gene-one enzyme hypothesis /one polypeptide hypothesis. Concept of operon of bacteria and bacteriophages. Bacterial transposons. Vertical and horizontal gene transfer. Transformation, transfection and transduction. Genetic complementation. Genetic mapping. Genetic screens as a basis for functional genomics. Deficiencies, EMS & X-ray-based mutagenesis screens. Creating alleles. Enhancer traps, EPLines, RNA-inheritance, FLP-FRT & Cre- Lox Systems. Behaviour mutant screens. Utility of the model organisms: Escherichia coli, Arabidopsis thaliana, Caenorhabditis elegans, Drosophila melanogaster & Mus musculus.	
Unit 4.	Human Population Genetics and Genetic Counselling	12hrs
	Human Genetics: Pedigree analysis; Karyotype, banding and nomenclature of chromosome subdivisions. Genetic disorders: chromosomal aneuploidy (Down, Turner and Klinefelter syndromes), chromosome translocation (Chronic Myeloid Leukemia) and deletion ("cry of cat" syndrome), gene mutation (sickle cell anemia). Genetic counselling, Gene isolation Manipulation and the techniques that revolutionized modern genetics.	
Unit 5.	Developmental genetics with model organisms	12 hrs
	Characteristics, natural history, importance and utility of the model organisms: <i>Escherichia coli</i> , <i>Arabidopsis thaliana</i> , <i>Caenorhabditis elegans</i> , <i>Drosophila melanogaster</i> & <i>Mus musculus</i> .	

Total – 60 hrs

Text books

1. Strickberger MW. 2012. Genetics (Macmillan). Prentice Hall of India Pvt Ltd. New Delhi.
2. Verma PS. Agarwal VK. 2004. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S. Chand Company, 2nd edition, New Delhi.
3. Gardner EJ. Simmons MJ. Snustad DP. 2008. Principles of Genetics. VIII Edition. Wiley India.

Reference books:

1. Snustad DP. Simmons MJ. 2009. Principles of Genetics. V Edition. John Wiley and Sons Inc.
2. Klug WS. Cummings MR. Spencer CA. 2012. Concepts of Genetics. X Edition. Benjamin Cummings.
3. Russell PJ. 2009. Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
4. Griffiths AJF. Wessler SR. Lewontin RC. 2007. Carroll SB. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
5. Fletcher H. Hickey I. 2015. Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

Course outcome:

1. Apply the principles of Mendelian inheritance
2. Understand the cause and effect of alterations in chromosome number and structure
3. Relate the conventional and molecular methods for gene manipulation in other biological systems
4. Discuss and analyse the epigenetic modifications, imprinting and their role in diseases
5. Get new avenues of joining research in related areas such as genetic engineering

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	M	H	M	H	H	M	H	H	H
CO 2	H	H	H	H	M	H	H	H	H	M	H	H	H
CO 3	H	H	H	H	M	H	H	H	H	H	H	H	H
CO 4	H	H	H	H	M	H	H	H	H	H	H	H	H
CO 5	H	H	H	H	M	H	H	H	H	H	H	H	H

Practicals VI- Genetics

Semester III
23BZOC06P

Hours of instruction / week: 4

No of credit: 2

Objectives:

- 1 To get an in-depth understanding on the principles and mechanisms of inheritance
- 2 To analyse the fine structure and molecular aspects of genetic material
- 3 To understand the importance of inheritance in Man and congenital diseases

1. Application of probability in the law of segregation with coin tossing 4 hrs
2. Frequency of the following genetic traits in human: widow's peak, attached ear lobe, dimple in chin, hypertrichosis, colour blindness, PTC tasting 6 hrs
3. Study of mode of inheritance of the following traits by pedigree charts – attached ear lobe, widow's peak 4 hrs
4. Familiarization with techniques of handling *Drosophila*, identifying males and females; observing wild type and mutant (white eye, wing less) flies, and setting up cultures 6 hrs
5. Demonstration of law of segregation (monohybrid and test cross) sex-linked inheritance in *Drosophila* making a cross between white eye dumpy winged or sepia eyed and wild type flies (criss-cross inheritance) 8 hrs
6. Demonstration of lethal alleles using Curly (Cy) mutant in *Drosophila* 8 hrs
7. Demonstration of multiple allelism by showing human blood groups 8 hrs
8. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs 6 hrs
9. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome) 4 hrs
10. Extraction of Genomic DNA from bacteria. 6 hrs
11. Group discussion or Seminar presentation on one or two related topics
 - Blood groups and their importance
 - Role of DNA sequencing in evolutionary history.
 - Genetic control of sex determination and genetic counselling

Total - 60 hrs

Course outcome

1. Expose the learners to the basics of genetics and genetic diseases
2. Acquire practical skills in monohybrid and test cross
3. Gain knowledge in the origin and inheritance of multiple alleles
4. Perform DNA isolation experiments from microorganisms
5. Introduce the new developments in genetics and its implications in human welfare

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	H	H	H	H	H	L	H	H	H
CO 2	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 3	H	H	H	H	M	H	H	H	H	H	H	H	H
CO 4	H	H	H	H	H	H	H	H	H	H	H	H	H
CO 5	H	H	H	H	H	H	H	H	H	H	H	H	H

Biochemistry

Semester IV
23BZOC07

Hours of instruction / week : 4
No of credit: 4

Objectives

1. To facilitate the students to understand the key principles of biochemistry
2. To enable the students to know about the structure of the biomolecules
3. To understand the metabolism of biological molecules

Unit 1: Introduction to Biochemistry	12 hrs
Introduction, scope and importance of Biochemistry, Structure of atoms, Chemical bonds, Acid and Base balance, Maintenance of blood pH- Blood buffers, Water as biological solvent – Structure and properties of water.	
Unit 2: Carbohydrates: Structure and metabolism	12 hrs
Classification, structure, and biological significance of carbohydrates, reducing and non-reducing sugars	
Metabolism - Glycolysis, TCA cycle, Electron transport chain and ATP synthesis, Glycogenesis, Gluconeogenesis and Glycogenolysis	
Unit 3: Lipids: Structure and Biological significance	12 hrs
Classification, structure of fatty acids, Triglycerides, Phospholipids, Sphingolipids, steroids, properties and biological significance of lipids	
Metabolism – β oxidation of palmitic acid and valeric acid, Ketogenesis	
Unit 4: Protein structure and metabolism	12 hrs
Amino acids - Structure, classification and properties, Physiological importance of essential and non-essential amino acids.	
Proteins: Structure, classification, properties and biological significance.	
Catabolism of amino acids: Transamination, Deamination, Urea cycle.	
Unit 5: Enzymes	12 hrs
Types, nomenclature, classification, general properties, specificity, cofactors, isozymes.	
Mechanism of enzyme action, Factors regulating enzyme activity, enzyme inhibition, allosteric regulation, concept of ribozymes and abzymes.	

Total - 60

Text Books:

1. Nelson, D.L. and Cox, M.M. (2021). Lehninger Principles of Biochemistry, Eighth edition, W.H. Freeman and Company, New York.
2. Berg, J.M., Tymoczko, J.L., Gatto, G.J. and Stryer, L. (2021) Biochemistry, Eighth edition, W.H. Freeman and Company, New York.
3. Satyanarayana, U. and Chakrapani, U. (2013). Biochemistry, Seventh Edition, Books and Allied Pvt. Ltd., Kolkatta and Elsevier, New Delhi.

Reference Books:

1. Rodwell V.W., Bender D.A., Botham K.M., Kennelly P.J., Weil P 2018. Harper's Illustrated Biochemistry, 31st edition. Tata McGraw Hill Companies Publication, New Delhi.
2. Voet, D., Voet, D.J. and Pratt, C.W. 2013. Fundamentals of Biochemistry – Life at molecular level, Fourth edition, John Wiley and Sons Inc., New York.
3. Rodney Boyer 2006. Concepts in Biochemistry, Third Edition, John Wiley and Sons Inc., United States
4. Zubay, G. 2017, Biochemistry, 4th edition, McGraw-Hill Publication, New Delhi.
5. Jain, J.L., Sunjay Jain, Nithin Jain 2005. Fundamentals of Biochemistry, Sixth Edition, S. Chand Publishing Company, New Delhi

Course Outcomes:

1. Understand the fundamental concepts and importance of biochemistry
2. Predict the atomic structure, chemical bonding and the acid- base reactions
3. Gain insight on the basic structure, classification and biological significance of biomolecules
4. Recognize the role of biomolecules in metabolism
5. Acquire knowledge on enzymes and their importance in biological reactions

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	H	-	L	L	M		M	H	H	M	H	H	H
CO 2	H	-	L	L		L	M		M		L	L	M
CO 3	H	-	M	M	M	M	M	H	H	M	H	H	H
CO 4	H	-	M	M	M	M	M	H	H	M	H	H	H
CO 5	H	-	M	M	M	M	M	H	H	M	H	H	H

Practicals VII - Biochemistry

Semester IV
23BZOC07P

Hours of instruction / week: 4
No of credit: 2

Objectives:

1. To acquire the basic lab skills, concepts and applications of scientific methods
2. To understand the principles and methodology for the qualitative and quantitative analyses of biomolecules
3. To enlighten the students how structural information can be utilized for better understanding of biological processes

1	Quantitative estimation of carbohydrates in fish sample	5 Hrs
2	Reactions for reducing sugar - Glucose	5 Hrs
3	Reactions for non reducing sugar - Starch	5 Hrs
4	Quantitative estimation of lipids in meat	5 Hrs
5	Determination of acid number of oil	5 Hrs
6	Quantitative estimation of proteins in fish sample	5 Hrs
7	Reactions for amino acids – Phenyl alanine	5 Hrs
8	Determination of the activity of enzyme at different pH	5 Hrs
9	Determination of the activity of enzyme at different temperature	5 Hrs
10	Identification of amino acids by paper chromatography	5 Hrs
11	Group discussion or Seminar presentation on one or two related topics from the list	10 Hrs
	<ul style="list-style-type: none"> • Essential and non essential amino acids • Important body lipids • Vital body enzymes 	

Total - 60 hrs

Course outcomes:

1. Understand the fundamental knowledge and basic concepts in the principles of Biochemistry
2. Demonstrate the common laboratory techniques used in Biochemistry.
3. Infer the biochemical constituents in biological samples.
4. Gain knowledge on the developments in biochemistry and its implication on human welfare
5. Interpret the results of analytical techniques

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	M	M	M	L	M	M	M	H	M	H	H	H
CO 2	H	M	M	M	L	M	M	L	H	H	M	M	M
CO 3	H	M	M	H	H	H	M	H	H	H	H	H	H
CO 4	H	M	H	H	H	H	H	H	H	H	H	H	H
CO 5	H	M	H	H	H	H	M	M	H	H	M	M	M

Ecology

Semester IV
23BZOC08

Hours of instruction / week: 4
No of credit: 4

Objectives:

1. To know the fundamental concepts, principles and various factors of ecology
2. To understand the characteristics and distribution of major biomes
3. To learn the importance of biodiversity and its conservation

Unit 1.	An overview of Ecology Introduction and scope of ecology. Structure and function of ecosystem. Abiotic factors affecting survival and sustenance of organisms-water, temperature, light, pH and salinity. Role of limiting factors in survival of biotic components. Energy flow in ecosystem, food chain and food web. Mineralization and recycling of nutrients: Carbon, nitrogen, phosphorus and sulfur.	10 hrs
Unit 2.	Habitat Ecology Major ecosystems (Aquatic and Terrestrial): Characterization and adaptation of animals in fresh water and marine habitat. Introduction to Biome: Ecological features of Tundra, Taiga, Grassland Desert, Savannah, Tropical Rain forest and Mangrove biomes.	10 hrs
Unit 3.	Population ecology and Human population growth Ecology of populations: Unitary and Modular populations. Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curve, age ratio, sex ratio. Factors regulating population dispersal and growth: Exponential and logistic growth. Population regulation: density-dependent and independent factors, r and K strategies. Metapopulations, demes and interdemec extinction. Life history strategies: reproductive effort, offspring size and cost-benefit ratio. Human population growth: Impacts on environment, carrying capacity, human health and welfare.	13 hrs
Unit 4.	Biotic community, characteristics and attributes Community characteristics: Stratification, dominance, diversity, species richness, abundance, evenness, similarity. Ecotone and edge effect. Types of interaction: Positive interactions- commensalism, proto-cooperation, and mutualism. Negative interactions: parasitism, allelopathy, predation and predator-prey dynamics, herbivory. Interspecific competition, coexistence, and abundance. Niche overlap and segregation. Gause's Principle. Ecological succession: Definition, Process, Types, Theories of succession.	14 hrs
Unit 5.	Biodiversity and its management Types of biodiversity - Hotspots, benefit and threat of conservation strategies; Biodiversity- status, monitoring and documentation; major drivers of biodiversity change; Biodiversity mapping using GPS, GIS and remote sensing. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and informational value. Application of ecology in management and conservation programmes. Role of gender and cultures in environmental conservation.	13 hrs

Total - 60hrs

Text Books:

1. Smith, TM and Smith RL 2015. Elements of Ecology, Pearson Education, India
2. Cain, ML, Bowman, WD and Hacker SD 2011. Ecology, 2nd Edition, Sinauer Associates Inc.
3. Odum, E. P. 2004. Fundamentals of Ecology, Oxford and IBH Publishing Co. Pvt. Ltd.
4. Peter Stiling.2015. Ecology: Global Insights & Investigations 2nd Edition. Mc Graw Hill international edition
5. Primack, Richard B and Anna Sher.2016. Introduction To Conservation Biology. Sinauer Associates, Incorporated, Publishers

References Books:

1. Colinvau, P. A. 1993. Ecology (2nd edition) Wiley, John and Sons, Inc.
2. Krebs, C. J. 2001. Ecology (6th edition) Benjamin Cummings.
3. Odum, E.P.2008. Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Ricklefs, R.E. 2000. Ecology (5th edition) Chiron Press.
5. Kendeigh, F C. 1984. Ecology with Special Reference to Animal and Man. Prentice HallInc
6. Stiling, P. D. 2012. Ecology Companion Site: Global Insights and Investigations. McGraw Hill Education

Course outcome

1. Know the evolutionary and functional basis of animal ecology.
2. Explore the distribution of global tropical and temperate biomes.
3. Knowledge on population growth and demography.
4. Imbibe the types and characteristics of community associated with an ecosystem
5. Appreciation of addressing current issues such as corridors, fragmentation, and ecosystem management from a landscape perspective.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	H	H	H	M	H	M	M	H	L	H	H	H
CO 2	H	M	H	H	M	H	M	-	H	-	H	M	H
CO 3	H	H	M	M	H	M	H	L	M	-	H	M	H
CO 4	H	H	H	H	M	M	L	-	H	L	H	H	H
CO 5	H	H	H	M	H	H	M	L	H	-	H	M	H

Practicals VIII – Ecology

Semester IV
23BZOC08P

Hours of instruction / week: 4
No of credit: 2

Objectives:

1. To understand the distribution of biotic and abiotic factors of the environment.
2. To recognize the interconnections among the major concepts of ecology
3. To study the behaviour of organism under natural conditions

1. Measurement of microclimatic variables viz., temperature, humidity and light conditions in a microhabitat. 5 hrs
2. Development of an ecosystem in a wide-mouthed bottle. 3hrs
3. Construction of a food web by observing and collecting organisms from a given area. 5 hrs
4. Presentation of a report based on the evaluation of 4-7 publications in ecology 3hrs
5. Study on the insect and host plant interaction. 5 hrs
6. Construction of distribution map of species of a genus through GPS by estimating the coordinates. 5 hrs
7. Investigation of volatile inhibitory substances through decomposition of plant debris and root exudates. 5 hrs
8. Estimation of the ratio of producers and consumers in a habitat 5 hrs
9. Study of insect diversity in a specific habitat. 5 hrs
10. Determination of frequency, density and abundance of different species in a community through quadrant study. 5hrs
11. Group discussion or Seminar presentation on one or two related topics 4 hrs
 1. Biodiversity Hotspots
 2. Climate change: threat to food security
 3. Air pollution
12. Field Visit 10 hrs
 - Visit to tropical rain forest
 - Visit to Mangrove forest

Total-60 hrs

Course outcome

1. Attain knowledge in the identification of different variables in microhabitat.
2. Analyze interactions within the context of specific habitats and judge how the habitat shapes the distribution and abundance of species.
3. Understand well the theoretical aspects taught besides learning techniques for gathering data in the field.
4. Learn about the complexity of natural resources and understand the conservation strategies of biodiversity
5. Apply management principles and tools to conserve diversity

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	H	M	H	H	M	M	-	M	H	L	H	M	M
CO 2	H	H	H	H	H	M	L	-	H	-	H	M	M
CO 3	H	M	H	H	M	H	M	-	H	-	M	L	H
CO 4	H	M	M	H	L	H	M	-	M	-	H	M	M
CO 5	H	L	H	-	M	H	H	M	H	-	H	M	H

Molecular Biology

Semester V
23BZOC09

Hours of instruction / week: 4
No of credit: 4

Objectives:

1. To elucidate central dogma of molecular biology
2. To acquire insight into the life processes at the subcellular and molecular levels
3. To understand synthesis and processing of RNA, DNA and protein

Unit 1. Central dogma: Detailed information on nucleic acids	15 hrs
---	---------------

Introduction to Molecular Biology, Central Dogma of Molecular Biology. Structure and Function of DNA, DNA forms: Plasmid DNA, Genomic DNA and Repetitive DNA. Conformation, Structure and Topology of DNA, DNA-modifications, DNA methylation. DNA-Protein interaction, DNA sequencing, DNA polymorphisms. Structure and Function of RNA, Ribosomal RNA (rRNA), Transfer RNA (tRNA), Messenger RNA (mRNA), Noncoding RNA

Unit 2. Chromosomes, DNA replication, recombination and repair	13 hrs
---	---------------

Chromosomes, Chromatin, Histones, Histone-modifications. DNA Replication, plasmid DNA replication and genomic DNA replication. DNA polymerases, other regulatory proteins, centromeric and telomeric DNA replication, DNA replication and cell cycle regulation. Mutation, DNA-damaging agents, DNA recombination. DNA repair, mismatch repair, single strand- and double strand DNA repair

Unit 3. RNA transcription, processing, editing and splicing	10 hrs
--	---------------

Transcription, RNA polymerase I, II, III, transcription factors, chromatin remodeling. RNA processing, splicing of hnRNA into mRNA, 5'-capping and 3'-polyadenylation of mRNA, rRNA and tRNA modifications and processing. RNA editing, alternative splicing, trans- splicing, miRNA, siRNA, piRNA, lncRNA, RNA-protein complex.

Unit 4. Ribosomes: Role in cell sustenance	10 hrs
---	---------------

Ribosomes, Genetic Code, triplet codons, Wobble base, synonymous codons, degeneracy of codons, missense-, nonsense- and frame shift mutations. Regulation of gene expression in prokaryotes and eukaryotes.

Unit 5. Translation, protein synthesis in E. coli and eukaryotic cells. Aminoacylation of tRNA, initiation, elongation, peptide bond formation, translocation, termination, recycling of ribosome, regulation of protein synthesis and codon bias. Post-translational modifications and processing of proteins, large protein-protein complexes and protein trafficking 12 hrs

Total 60 hrs

Text Books:

1. Watson, J.D. et al. (2013) Molecular Biology of the Gene (7th edition) CSHL Press Pearson
2. Green, M. R and Sambrook, J. (2012) Molecular Cloning: a Laboratory Protocol (4th edition) CSHL Press
3. Walter, P. (2007) Molecular Biology of the Cell (5th edition) Garland Science.

References Books:

1. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.
2. Karp, G., Iwasa, J., Marshall, W. (2015). Cell and Molecular Biology: Concepts and Experiments, 8th Edition. John Wiley & Sons, Inc.,
3. Darnell, Lodish and Baltimore. (2000). Molecular Cell Biology, Scientific American Publishing Inc,

Course Outcomes:

1. Understand structure of nucleic acids and basic concepts of protein synthesis
2. Describe the molecular mechanisms behind DNA replication in prokaryotes and eukaryotes
3. Comprehend RNA synthesis and processing, and protein synthesis
4. Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.
5. Understand and apply general concepts of cell and molecular biology to relevant, specific problems.

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO1	PSO2	PSO3
CO 1	M	M	H	H	L	-	H	-	-	L	H	-	-
CO 2	H	L	L	L	H	L	H	-	L	-	H	L	L
CO 3	M	M	L	-	M	L	L	L	M	L	L	M	M
CO 4	M	H	M	H	M	-	H	M	L	M	H	L	L
CO 5	H	H	L	H	L	L	M	L	-	M	M	-	-

Practicals IX –Molecular Biology

Semester V
23BZOC09P
Objectives:

Hours of instruction / week: 4
No of credit: 2

1. Learn methods for the isolation and estimation of genomic DNA
2. Acquire skills techniques for the isolation of plasmid DNA
3. Get expertise in the techniques for separation of biomolecules
 1. Creation of a ball-and-stick model for b-DNA molecule with A=T and G=C base pairs 5hrs
 2. Extraction of DNA from onion samples 5hrs
 3. Estimation of DNA content in onion extracts – Diphenylamine method 5hrs
 4. Isolation of DNA from goat liver tissue 5hrs
 5. Estimation of DNA concentration in goat liver extracts - Diphenylamine method 5hrs
 6. E coli culture-preparation for isolating plasmid DNA 5hrs
 7. Isolation of the plasmid DNA from the *E. coli* culture by alkaline lysis method. 5hrs
 8. Separation of plasmid DNA fragments through agarose gel electrophoresis 5hrs
 9. Separation of genomic DNA fragments through agarose gel electrophoresis 5hrs
 10. Demonstration on PCR 5hrs
 11. Demonstrating Protein Separation via SDS-PAGE (Sodium Dodecyl Sulfate Polyacrylamide Gel Electrophoresis) 5hrs
 12. Group discussion or Seminar presentation on one or two related topics from the list 5hrs
 - 1.Regulation of gene expression
 2. RNA editing and splicing
 3. Central dogma of molecular biology

Total 60hrs

Course Outcomes:

1. Acquire practical skills in undertaking simple molecular biology experiments
2. Get expertise in isolation and estimation of Genomic DNA
3. Perform techniques for isolation and separation of biomolecules
4. Get expertise in isolation of plasmid DNA
5. This practical experience would enable them to begin a career in biotech as well as pharmaceutical industry

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M			L	H	H	L	H	M	H	L	M	H
CO 2	L	M		M	H	H		M	M	H	M		H
CO 3	M		M	L	M	H	L	M	H	H	M	L	
CO 4	M	L	M	L	L		M	H		H		L	M
CO 5	M	L		M	L	M	L	M	H		M		M

Biotechniques

Semester V

23BZOC10

Hours of instruction / week: 4

No of credit: 4

Objectives:

1. To facilitate the students to understand the key principles and techniques of biotechniques
2. To understand the importance and applications of biotechniques
3. To enable the students to understand the basic principles and functions of various instruments

Unit 1. Microscopy and Microtomy	12 hrs
Microscopy: Introduction to Microscopy. Definitions-Resolving Power, Limit of Resolution and Magnification, Numerical Aperture. Types of microscopes- Bright field, Dark-field, Phase contrast, Light, Scanning Electron, Transmission electron, Fluorescence and Confocal microscopy. Microtomy: Tissue preparation, fixation, block preparation, sectioning, staining, dehydration and mounting.	
Unit 2. Tools and techniques in Biochemistry and Physiology	12hrs
Biochemistry and Physiology: Physiological Salines, Buffers and the use of pH meter. Cell Fractionation techniques-Homogenisation, Differential, density gradient and ultra centrifugation. Beer-Lambert's Law, Colorimetry and Spectrophotometer.	
Unit 3. Chromatography and Electrophoresis	12 hrs
Principle and applications of Electrophoresis: Separation of Biomolecules by Native PAGE, 2D PAGE. Agarose gel electrophoresis. Principle and Applications of Paper chromatography, High Performance Liquid Chromatography Thin layer chromatography.	
Unit 4. Tools and Techniques in immunology	12hrs
Immunology and Endocrinology: Introduction to Antigens, Antibodies, Adjuvants. Polyclonal and Monoclonal Antibodies. Antigen-Antibody Interactions- Immunodiffusion, Ouchterlony's Double Immunodiffusion, Counter-Current, Immunoelectrophoresis, Western Blotting, ELISA, RIA.	
Unit 5. Cell culture, maintenance of Laboratory animals	12 hrs
Cell Culture and Laboratory Animals: Cell culture and its basic requirements. Culture media- Nutrient and Non-nutrient, commonly used media for human cell lines. Sterilization of culture wares and Media. Types of animal cell culture, cell viability testing. cryopreservation. Lymphocyte culture. Cell harvesting and Storage Methods. <i>In Vitro</i> culture of <i>Entamoeba histolytica</i> , <i>Coenorhabditiselegans</i> . Maintenance and Handling of laboratory rats and rabbits.	

Total 60 hrs

Text books:

1. Rana, S.V.S. (2009), Biotechniques theory and Practical, Rastogi Publications Meerut, India.
2. Murray RK, Bender DA, Bootham KM, Kennlley PJ, Rodwell VW, Weil PA. Harpers Illustrated Biochemistry, Twenty ninth Edition, Tata McGraw Hill Companies' Publication, New Delhi, 2012.
3. Lehninger AL, Nelson DL, Cox MM. Principles of Biochemistry, Fifth edition, CBS Publishers and Distributors, New Delhi, 2008.
4. Satyanarayana U, Chakrapani U. Biochemistry, Seventh Edition, Books and Allied Pvt. Ltd., New Delhi, 2013.

5. Wilson K, Walker J, Practical Biochemistry – Principles and Techniques, Eighth Edition, Cambridge University Press, India, 2018.

Reference books:

1. Boyer, R. (2000) Modern Experimental Biochemistry (3rd edition) Benjamin-Cummings.
2. Pearse, A.G.E. (1980-1993) Histochemistry - Theoretical and applied, Volume I-III, Churchill-Livingstones.
3. Plummer, D. (2017) An Introduction to Practical Biochemistry (3rd edition) McGraw Hill.
4. Wilson, K. and Walker, J. (2010) Experimental Biochemistry, Cambridge.

Course outcome:

1. Understand the purpose of the technique, its proper use and possible modifications/ improvement.
2. Learn the theoretical basis of technique, its principle of working and its correct application.
3. Gain knowledge about the construction repair and adjustment of any equipment required for a technique.
4. Analyse the technique of cell and tissue culture and preparation of solution of given percentage and molarity.
5. Imparting the process of preparation of buffer and techniques of separation of amino acids, proteins and nucleic acids.

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO 10	PS O1	PS O2	PS O3
CO 1	H	M	H	H	M	H	H	H	H	H	-	M	H
CO 2	H	L	H	H	H	H	M	M	H	H	-	L	H
CO 3	H	M	H	H	M	H	H	H	H	H	-	M	H
CO 4	H	M	H	H	M	H	H	H	H	H	-	M	H
CO 5	M	M	H	H	H	H	M	M	H	H	-	L	H

Practicals X - Biotechniques

Semester V
23BZOC10P

Hours of instruction / week: 4
No of credit: 2

Objectives:

1. Able to demonstrate an understanding of fundamental biochemical principles
2. To enable the students to know the molecular based techniques
3. To describe the biotechnological techniques in research problems

- | | |
|--|-------|
| 1. Preparation of buffer and determination of pH. | 4 hrs |
| 2. Determination of wavelength in colour solution using a UV-Vis Spectrophotometer | 6 hrs |
| 3. Identification of amino acids using paper chromatography | 6 hrs |
| 4. Separation and identification of amino acids by TLC-demonstration | 6 hrs |
| 5. Separation of proteins using SDS-PAGE. | 8 hrs |
| 6. Tissue fixation, paraffin block preparation, sectioning. | 8 hrs |
| 7. Preparation of permanent slides of microscopic organisms/ small insects | 4 hrs |
| 8. HPLC demonstration | 8 hrs |
| 9. Demonstration of bright field, Fluorescence and Electron microscopes | 4 hrs |
| 10. Group Discussion: | |
| • Immunological techniques in disease diagnosis | |
| • Basic principles of light microscopy | |
| • Using SEM and TEM | |
| • Applications of Colorimetry and spectrophotometry | |

Total 60 hrs

Course outcome:

1. Understand the purpose of the technique, its proper use and possible modifications/ improvement.
2. Analyse the construction repair and adjustment of any equipment required for a technique.
3. Learn the accuracy of technique.
4. Ability to the maintenance laboratory equipment/ tools, safety hazards and precautions.
5. Gain Knowledge the techniques of separation of amino acids, proteins and nucleic acids.

CO/ PO	PO1	PO2	PO3	PO4	PO	PO	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO 1	H	M	H	H	M	H	H	H	H	H	-	M	H
CO 2	H	L	H	H	H	H	M	M	H	H	-	L	H
CO 3	H	M	H	H	M	H	H	H	H	H	-	M	H
CO 4	H	M	H	H	M	H	H	H	H	H	-	M	H
CO 5	M	M	H	H	H	H	M	M	H	H	-	L	H

Microbiology, Parasitology and Immunology

Semester VI

23BZOC11

Hours of instruction / week: 4

No of credit: 4

Objectives:

1. To recognize the similarities and differences between microbial groups
2. To enable the students to know the biology and pathogenesis of infectious diseases
3. To understand the role of microbes in various fields.

Unit 1. Historical development and microbial culture techniques	12 hrs
History of microbiology. Classification of microbial kingdom. Structure of bacteria, fungi and virus. Microbial culture and growth: Sterilization, media types and preparation, sample collection, isolation and maintenance of microbes, bacterial growth pattern, factors affecting growth, measurements of growth.	
Unit 2. Bacterial, Fungal and Viral diseases	12 hrs
Bacterial diseases - <i>Bacillus anthracis</i> , <i>Streptococcus pyogenes</i> , <i>Streptococcus pneumoniae</i> , <i>Salmonella typhi</i> , <i>Escherichia coli</i> , <i>Helicobacter pylori</i> , <i>Mycobacterium tuberculosis</i> , <i>Vibrio cholerae</i> . Fungal diseases - Ringworm infection, aspergillosis, candidiasis. Viral diseases - Polio, rabies, hepatitis, influenza, dengue, AIDS, chicken pox, swine flu, chikungunya with emphasis on their causative agents, symptoms, mode of transmission, pathogenesis, diagnosis, prophylaxis and chemotherapy.	
Unit 3. Parasitology	12 hrs
Introduction to parasites and parasitic diseases. Mode of transmission, portal of entry and implications of parasitism. Parasitic adaptations. Concept of zoonotic diseases. Protozoan diseases of medical importance: Amoebiasis, giardiasis, malaria, trypanosomiasis, leishmaniasis and toxoplasmosis. Helminthic diseases of medical importance: Schistosomiasis, taeniasis, echinococcosis, ascariasis, enterobiasis, dracunculiasis and filariasis.	
Unit 4. Immunology- Immune mechanism	12 hrs
Cells and organs of the immune system- primary and secondary lymphoid organs. Innate immunity- First and second lines of defense, acquired immunity - vaccine. Characteristics of antigen- antigenicity and immunogenicity, epitopes, haptens, adjuvant. Factors influencing immunogenicity. Classical and molecular structure of immunoglobulin. Classification, properties and functions of immunoglobulins. Antigenic determinants: isotype, allotype and idiotype. Antigen and antibody interactions, affinity, avidity. Complement system - Classical and alternative pathways.	
Unit 5. Immune response, hypersensitivity, and transplantation immunology	12 hrs
Humoral and cell mediated immune response. Role of B and T cell in immunity. Receptors, activation and differentiation of B and T cells. Cytokines- Properties and functions. MHC complex and functions. Hypersensitivity .Types of graft rejection, graft acceptance and rejection. Antigen processing and their presentation.	

Total 60 hrs

Text books:

1. Willey, J., Sherwood, L., Woolverton, C.J. (2016). Prescott's Microbiology. 10th edition, Mc-Graw- Hill Publishing Company Ltd., New Delhi.
2. Dubey, R.C. and Maheswari, D.K. (2000). A text book of Microbiology. 4th edition, S. Chand and Company Ltd, New Delhi.
3. Kuby, J. (2007). Immunology. 6th edition, W.H. Freeman and Co, New York.
4. Banarjee, A. and Nirmala, B. (2006). Fundamentals of Microbiology and Immunology. New Book Agency, Kolkata.
5. Delves, P., Martin, S., Burton, D. and Roitt, I.M. (2006). Roitt's Essential Immunology. 11th edition, Wiley-Blackwell Scientific Publication, Oxford.
6. Chatterjee, K.D. (2015). Parasitology (Protozoology and Helminthology), 13th edition, CBS Publishers & Distributors Pvt Ltd, India

Reference books:

1. Jeffrey Pommerville. (2014). Alcamo's Fundamentals of Microbiology. (1st edition), Jones and Bartlett India Pvt. Ltd., New Delhi.
2. Talaro, K.P and Talaro, A. (2002). Foundations in Microbiology. (4th edition), Mc-Graw - Hill Education, New York.
3. Murphy, K., Travers, P. and Walport, M. (2008). Immunology. Garland Science, UK.
4. David, K. M., Jonathan, David, B.R. and Ivan, M.R. (2013). Immunology. (8th Edition), Elsevier-Saunders publications.
5. Paniker, C.K. (2018). Textbook of Medical Parasitology, Jaypee Brothers Medical Publishers Pvt. Ltd., New Delhi

Course outcomes:

1. Gain knowledge on microbial diversity and its significance
2. Apply culture techniques in clinical and research problems
3. Assess the importance of incidence, prevalence and epidemiology in microbiological and parasitological diagnostic activities.
4. Understand the characteristic features and interplay of the various components of the immune system
5. Analyse the principles underlying hypersensitivity and transplantation of graft tissues

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PSO1	PSO2	PSO3
CO 1	H	-	L	L	-	H	M	-	H	-	H	L	H
CO 2	H	M	H	H	H	H	H	M	H	-	-	-	H
CO 3	H	-	H	H	-	H	H	M	H	L	H	H	H
CO 4	H	-	L	H	-	H	L	-	H	-	-	M	L
CO 5	M	M	L	H	H	-	H	-	M	L	-	M	-

Practicals XI - Microbiology, Parasitology and Immunology

Semester VI
23BZOC11P

Hours of instruction / week: 4
No of credit: 2

Objectives:

1. To enable the students to isolate and identify the microbes and parasites
2. To understand the factors that influence microbial growth.
3. To know the functions and usage of immunologic testing.

1.	Isolation and enumeration of microbes from soil	5 hrs
2.	Isolation and enumeration of microbes from water	5 hrs
3.	Identification of fungi by lacto phenol cotton blue staining	5 hrs
4.	Identification of Gram positive and Gram negative bacteria	5 hrs
5.	Determination of Microbial growth - Turbidity method.	5 hrs
6.	Antibiotic sensitivity test	5 hrs
7.	Study of permanent slides and specimens of parasitic protozoans and helminthes	5 hrs
8.	Haemagglutination	5 hrs
9.	Demonstration of antigen-antibody interaction.	5 hrs
10.	Single radial immunodiffusion	5 hrs
11.	Precipitin ring test	5 hrs
12.	Group discussion or Seminar presentation on related topics	5 hrs
	• Zoonotic diseases	
	• Diseases caused by viruses	
	• Concept of Immunity	
	• Immunological techniques in disease diagnosis	
	• Blood groups and their importance	

Total 60hrs

Course Outcomes:

1. Acquire practical skills in undertaking simple immunological experiments that mimic those undertaken in diagnostic and research laboratories.
2. Coherently report in a written document using the appropriate language of the field
3. Understand the principle and operation of relevant laboratory equipment.
4. Evaluate laboratory test outcomes and determine the validity of the test results obtained.
5. Perform experiments using techniques for isolation and separation of biomolecules

Applied Zoology

Semester VI
23BZOC12

Hours of instruction / week: 4
No of credit: 4

Objectives:

1. To disseminate information on economic aspects of Zoology
2. To inculcate knowledge on useful animals to mankind and develop entrepreneurial skills
3. To understand the modern techniques of animal culture

Unit 1. Aquaculture	12 hrs
Prawn culture: Culture of fresh water prawn and marine prawn; preparation of farm, preservation and processing of prawn. Export of prawn. Fish Culture: Breeding Pond, Fish Seed, Hatching pond. Transport of fish fry to rearing ponds. Harvesting, preservation of fish. Composite fish farming. By products of fishing industry and common fish diseases.	
Unit 2. Apiculture	12hrs
Types of honey bee species, life cycle of <i>Apisindica</i> . Methods of bee keeping, Newton's Bee hive. Extraction of honey, uses of by-products and the medicinal properties of honey. Natural enemies and their control. Social behaviour of honey bees, Importance of bee colonies in crop pollination.	
Unit 3. Vermiculture	12 hrs
Earthworm- External features fertilization, cocoon formation and development of earth worm.common species for culture; Environmental parameters; culture methods – wormery – breeding techniques; indoor and outdoor cultures - monoculture and polyculture merits and demerits. Harvesting the compost, storage, Vermiwash-Preparation and application.	
Unit 4. Sericulture	12hrs
Silkworm morphology: Morphology of the egg, larva, pupa, adult. Types of silkworms and their host plants. Methods of silkworm rearing, rearing appliances and cocoon harvesting. Post cocoon technology and silk production	
Unit 5. Poultry farming	12 hrs
Types of breeds. Rearing method. Diseases and control measures. Breeds of fowl, Housing and Equipment, Deep litter System, Laying cages, Methods of brooding and Rearing, De-beaking. Management of growers, Layers, Broilers; Feed formulations for chicks, Diseases of fowl. Nutritive value of egg and meat. Incubation and hatching of eggs.	
Total 60hrs	

Text books:

1. Sarkar, Kundu and Chaki (2014). Introduction to Economic Zoology. NCBA Publication, Kolkata
2. Jabde, P. V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture
3. Sultan Ahmed Ismail (2005). The Earthworm Book, Second Revised Edition. Other India Press, Goa, India

4. Morohoshi, S (2000) Development, and Physiology of Silkworm. Oxford &Ibh Publishing Co, Pvt. Ltd., New Delhi

Reference books:

1. Aravind Kumar, (2005).Verns & Vermitechnology, A.P.H. Publishing Corporation, New Delhi
2. Basava Raja, H.K., Aswath, S.K., Suresh Kumar, N., Mal Reddy, N. And Kalpana, G.V. (2005) Silkworm Breeding And Genetics. Central Silk Board, Bangalore
3. Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
4. Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.

Course outcome:

1. Gain skillset and professional knowledge in animal rearing
2. Inculcate theoretical insights of establishment of farm, challenges and marketing
3. Accelerate breeding of indigenous native breeds system of livestock
4. Identify the disease and management strategies in farm animals and birds.
5. Adopt the SDGs and impact the development of rural people.

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO 9	PO10	PSO1	PSO2	PSO3
CO 1	H	M	H	H	H	H	L	H	M	H	H	L	H
CO 2	H	H	H	H	M	H	M	H	H	H	M	M	H
CO 3	H	L	H	H	L	H	L	H	M	H	H	M	H
CO 4	H	M	H	M	M	H	H	L	M	H	M	-	H
CO 5	M	H	H	H	M	H	M	H	M	H	M	-	H

Practicals XII - Applied Zoology

Semester VI
23BZOC12P

Hours of instruction / week: 4
No of credit: 2

Objectives:

1. To disseminate information on economic aspects of Zoology
2. To inculcate knowledge on useful animals to mankind and develop entrepreneurial skills
3. To understand the modern techniques of animal culture

1.	Morphometric analysis of common fish species.	6hrs
2.	Composting of agricultural wastes and house-hold waste using earthworms.	4hrs
3.	Mounting of the sting apparatus of Honey bee.	4hrs
4.	Morphological differentiation of Queen, Drone and Worker bees in honey comb.	4hrs
5.	Examination of wax moth in honey comb.	6hrs
6.	Identification of commonly available fishes.	6hrs
7.	External morphology and life cycle of common earthworm species.	6hrs
8.	Life cycle of mulberry silkworm, <i>Bombyx mori</i> (model/chart/specimens)	4hrs
9.	Pests of silkworm- video demonstration	6hrs
10.	External morphology and nomenclature of dairy animals.	4hrs
11.	Project report on visit to sericulture and apiculture farm	4hrs
12.	Project report on visit to fish culture and organic farm	6hrs
Total		60hrs

Course outcomes

1. Understand the importance on the choice of animals breeds
2. Establish small sale animal farms and apply various concepts of economic zoology
3. Provide employment opportunities and Improved socio-economic development in rural areas
4. Portray the economic value of animal husbandry among the stakeholders
5. Avenues for improving the market value of animal by-products

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PSO 1	PSO 2	PSO 3
CO 1	M	L	M	H	L	M	M	M	H	H	H	L	H
CO 2	H	L	M	H	H	H	L	H	H	H	M	-	H
CO 3	H	H	H	H	H	H	L	H	H	H	L	-	H
CO 4	H	M	H	M	M	H	M	M	H	H	M	L	H
CO 5	H	M	M	H	H	H	M	H	H	H	L	L	H