

SCHEME AND SYLLABUS

FOR

- **UG Certificate in Zoology: 1 year**
- **UG Diploma in Zoology: 2 years**
- **UG Degree in Zoology: 3 years**
- **UG (honours with research) in Zoology: 04 years**
- **UG (honours) in Zoology: 04 years**

Under

National Education Policy 2020

**Department of Zoology, School Of Life Sciences
Guru Ghasidas Vishwavidyalaya, Bilaspur (CG)**

2024-25

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Scheme and Syllabus for UG Courses in Zoology

**Department of Zoology, School of Studies of Life Sciences,
Guru Ghasidas Vishwavidyalaya, Bilaspur**

Semester	Courses	Name of courses	Code	Number of courses	Level	Credits	Total Credits
I	Major	Animal Diversity of Non chordates (Protista to Pseudocoelomate)	ZOUAMJT1	1	2	3	18
		Lab Course	ZOUAMJL1			1	
	Minor	Minor 1 To be offered to the students of other departments	ZOUAMNT1	1	2	3	
		Lab Course	ZOUAMNL1			1	
	Multidisciplinary	Multidisciplinary 1 To be offered to the students of other disciplines (except Natural and Physical Sciences)	ZOUAMDT1	1	1	3	
	SEC	SEC 1 To be offered to students of Zoology/other departments at University level	ZOUASET1	1	1	2	
		Lab Course	ZOUASEL1			1	
	VAC	VAC 1 To be offered to the students of Zoology/other departments at University level	ZOUAVAT1	2	1	2	
	AEC	Language To be offered by Hindi/English Department for student of Zoology		1	1	2	
II	Major	Animal Diversity of Non chordates (Coelomates)	ZOUBMJT1	1	2	3	18
		Lab Course	ZOUBMJL1			1	
	Minor	Minor 2 To be offered to the students of other departments	ZOUBMNT1	1	2	3	
		Lab Course	ZOUBMNL1			1	
	Vocational	Vocational 1 To be offered to the students of Zoology/other departments at University level	ZOUBVOT1			1	
		Ornamental Fish Culture Lab Course	ZOUBVOL1			3	
	Multidisciplinary	Multidisciplinary 2 To be offered to the students of other disciplines (except Natural and Physical Sciences)	ZOUBMDT1	1	1	3	
	SEC	SEC 2 To be offered to the students of Zoology/other departments at University level	ZOUBSET1	1	1	2	
		Lab Course	ZOUBSEL1			1	
	VAC	VAC 2 To be offered to the students of Zoology/other departments at University level	ZOUBVAT1	2	1	2	
	AEC	Language To be offered by Hindi/English Department for student of Zoology		1	1	2	

The student must complete the 4 credits vocational course/Internship during summer term to get UG Certificate if he wishes to exit the program after first 2 semesters.

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III	Major	Diversity of Chordates	ZOUCMJT1	2	3	3	20					
		Lab Course	ZOUCMJL1			1						
		Cell biology	ZOUCMJT2			3						
		Lab Course	ZOUCMJL2			1						
	Minor	Minor3	ZOUCMNT1	1	3	3						
		To be offered to the students of other departments										
	Vocational	Lab Course	ZOUCMNL1			1						
		Vocational 2	ZOUCVOT1			1						
		To be offered to the student of Zoology/other departments at University level										
		Histological Techniques and Light Microscopy-Lab Course	ZOUCVOL1			3						
	Multidisciplinary	Multidisciplinary 2		1	1	3						
	SEC	To be offered to the students of other disciplines (except Natural and Physical Sciences)										
		SEC 3	ZOUCSET1	1	1	2						
	To be offered to the students of Zoology/other departments at University level											
Lab Course	ZOUCSEL1			1								
AEC	Language		1	1	2							
To be offered by Hindi/English Department for student of Zoology												
IV	Major	Microbiology and Parasitology	ZOUDMJT1	3	3	3	20					
		Lab Course	ZOUDMJL1			1						
		Fundamental Biochemistry	ZOUDMJT2			3						
		Lab Course	ZOUDMJL2			2						
		Ecosystem Dynamics and Conservation / Complex ecosystem Dynamics (MOOCS)	ZOUDMJT3			3						
		Lab Course				2						
			ZOUDMJL3			2						
			ZOUDMNT1			3						
	Minor	Minor 4		1	3							
		To be offered to the students of other departments										
	Vocational	Lab Course	ZOUDMNL1			1						
		Vocational 3	ZOUDVOT1			1						
		To be offered to the students of Zoology/other departments at University level										
		Medical diagnostics Lab Course	ZOUDVOL1			3						
	AEC	Language		1	1	2						
	To be offered by Hindi/English Department for student of Zoology											
	The student must complete the 4credits vocational course/Internship either after first year or second year during summer term to get UG Diploma if he wishes to exit the program after first 4 semesters.											
	V	Major	Physiology of Basic Life Process	ZOUEMJT1	3	4		3	21			
			Lab Course	ZOUEMJL1				2				
			Bioinstrumentation	ZOUEMJT2				3				
			Lab Course	ZOUEMJL2				2				
			Principle of Genetics and Evolution	ZOUEMJT3				3				
			Lab Course	ZOUEMJL3				2				
			Minor	Minor 5 (To be offered to the students of other departments)				ZOUEMNT1		1	4	3
			Lab Course	ZOUEMNL1				1				

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	Internship	During Winter Break	ZOUUEL1	-	-	2	
VI	Major	Physiology of Regulatory Life Process	ZOUFMJT1	3	4	3	19
		Lab Course	ZOUFMJL1			2	
		Elements of Molecular Biology	ZOUFMJT2			3	
		Lab Course	ZOUFMJL2			2	
		Reproductive and Developmental Biology	ZOUFMJT3			3	
		Lab Course	ZOUFMJL3			2	
	Minor	Minor 6	ZOUFMNT1	1	4	3	
		To be offered to the students of other departments					
		Lab Course	ZOUFMNL1			1	

The students who wish to exit after six semester upon securing 120 credits will be awarded UG degree in relevant subject/discipline.

After sixth semester, there will be two streams: (I) UG (Honours with research) and (II) UG (Honours).

The students who will secure 75% and above may opt for UG (Honours with research).

(I) Course structure for UG (Honours with research)

VII	Major	Immunology	ZOUGMJT1	3	5	3	20
		Lab Course	ZOUGMJL1			2	
		Endocrinology	ZOUGMJT2			3	
		Lab Course	ZOUGMJL2			2	
		Toxicology	ZOUGMJT3			3	
		Lab Course	ZOUGMJL3			2	
	Minor	Minor 7	ZOUGMNT1	1	5	3	
		Lab Course	ZOUGMNL1			1	
		Seminar				1	
VIII	Major	Research Methodology and Biostatistics	ZOUHMJT1	1	5	3	22
		Lab Course	ZOUHMJL1			2	
	Minor	Minor 8	ZOUHMNT1	1	5	3	
		Lab Course	ZOUHMNL1			2	
	Research project/ Dissertation			-	-	12	

(II) Course structure for the UG (Honours)

VII	Major	Immunology	ZOUGMJT1	3	5	3	20
		Lab Course	ZOUGMJL1			2	
		Endocrinology	ZOUGMJT2			3	
		Lab Course	ZOUGMJL2			2	
		Toxicology	ZOUGMJT3			3	
		Lab Course	ZOUGMJL3			2	
	Minor	Minor 7	ZOUGMNT1	1	5	3	
		Lab Course	ZOUGMNL1			1	
	Seminar			-	-	1	
VIII	Major	Research Methodology and Biostatistics	ZOUHMJT1	2	5	3	22
		Lab Course	ZOUHMJL1			2	
		Applied Zoology	ZOUHMJT2			3	
		Lab Course	ZOUHMJL2			2	
	Minor	Minor 8	ZOUHMNT1	2	5	3	
		Lab Course	ZOUHMNL1			2	
		Minor 9	ZOUHMNT2			3	
		Lab Course	ZOUHMNL2			2	
	Seminar			-	-	2	

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As per NEP-2020, Department of Zoology will offer minor courses, multidisciplinary courses (MDC), ability enhancement courses (AEC), skill enhancement courses (SEC), value added courses (VAC) and vocational courses (VOC) to students of other departments.

Similarly, student of Department of Zoology will study these courses from the courses offered by other departments/ as per University decision.

Pool for minor course, multidisciplinary course, AEC, SEC, VAC and vocational course will be given by University.

Two AEC courses are compulsory in first 2 semesters (One in each semester).

Three SEC courses are compulsory in first 3 semesters (One in each semester).

Three Multidisciplinary courses are compulsory in first 3 semesters (One in each semester).

Four VAC courses are compulsory in first 2 semesters (Two in each semester).

One vocational course for certificate and diploma courses, three vocational courses for 3/ 4 year degree are compulsory.

List of minor courses, multidisciplinary courses, AEC, SEC, VAC and vocational courses offered by the department of zoology (in University pool) is as follows:

Minor Courses

S. N.	Title	Course Name
1.	Minor 1	Animal Diversity of Non chordates (Protista to Pseudocoelomate)
2.	Minor 2	Animal Diversity of Non chordates (Coelomates)
3.	Minor 3	Diversity of Chordates
4.	Minor 4	Microbiology and Parasitology
5.	Minor 5	Physiology of Basic Life Processes
6.	Minor 6	Physiology of Regulatory Life Process
7.	Minor 7	Immunology
8.	Minor 8	Research Methodology and Biostatistics
9.	Minor 9	Applied Zoology

Multidisciplinary Courses

S. N.	Title	Course Name
1.	Multidisciplinary 1	Introductory Zoology
2.	Multidisciplinary 2	Essentials of Zoology

Skill Enhancement Courses

S. N.	Title	Course Name
1.	SEC 1	Aquaculture
2.	SEC 2	Apiculture
3.	SEC 3	Sericulture

Value Added Courses

S. N.	Title	Course Name
1.	VAC 1	Bhartiya Vigyan Ka Itihas
2.	VAC 2	Food Nutrition and Health (Health & wellness)

Vocational Courses

S. N.	Title	Course Name
1.	VOC 1	Ornamental Fish Culture
2.	VOC 2	Histological Techniques and Light Microscopy
3.	VOC 3	Medical Diagnostics

Department may offer at least one paper in whole UG program on MOOC's platform and it will be compulsory to all students.

Summer and/or winter internship: duration will be 2-4 weeks (minimum 90 working hours).

Abbreviations:

AEC= Ability enhancement course; SEC= Skill enhancement course; VAC= Value added course

(Subject to approval by the competent authority)

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Major Course: ZOUAMJT1 and ZOUAMJL1

Semester	Major Course	Course Title	Credits
I	1	Animal Diversity of Non chordates (Protista to Pseudocoelomate)	Theory: 03 Practical: 01

About the course

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Course outcomes

After successfully completing this course, the students will be able to:

1. Develop understanding on the diversity of life with regard to protists to pseudocoelomata.
2. Group animals on the basis of their morphological characteristics/ structures.
3. Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
4. Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
5. Understand how morphological change due to change in environment helps drive evolution over a long period of time.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Protista, Parazoa and Metazoa

14 Lecture

General characteristics and classification up to classes; Study of *Euglena*, *Amoeba* and *Paramecium*; Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*; Locomotion and Reproduction in Protista; Types of symmetry.

Unit 2: Porifera

08 Lecture

General characteristics and classification up to classes; Type study of *Sycon*; Canal system and spicules in sponges.

Unit 3: Cnidaria

10 Lecture

General characteristics and classification up to classes; Type study of *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs.

Unit 4: Platyhelminthes

10 Lecture

General characteristics and classification up to classes; Type study, larval forms and pathogenicity of *Fasciola hepatica*.

Unit 5: Nematelminthes

8 Lecture

General characteristics and classification up to classes; Type study of *Ascaris lumbricoides*; Life cycle and pathogenicity of *Wuchereria bancrofti*; Parasitic adaptations in helminthes.

Practical

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*.
2. Binary fission and Conjugation in *Paramecium*.
3. Examination of pond water collected from different places for diversity in Protista.
4. Study of Sycon (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*.
5. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*.
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs).
7. Study of adult *Ascaris lumbricoides* and its life stages (slides/microphotographs).
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

Major Courses: ZOUBMJT1 and ZOUBMJL1

Semester	Major Course	Course Title	Credits
II	2	Animal Diversity of Non chordates (Coelomates)	Theory: 03 Practical: 01

About the course

To discuss representative lineages of the protostome coelomates, including molluscs, annelids and arthropods. Students will know how are these groups of animals similar? What morphological and developmental patterns do they have in common? How do they differ?

They will know the importance of segmentation in the annelids. Students will come to know why the animals in Phylum Arthropods are thought to be so successful.

Course Outcomes

1. Compare the two groups (Acoelomate and Coelomates) of animals with true coeloms.
2. Compare the differences in development seen in these two groups.
3. Compare the protostomes and deuterostomes
4. Explain the characteristics of arthropods that have made them successful.
5. Review the diversity of arthropod groups, including trends in arthropod evolution.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Coelomates and Annelida

12 Lectures

Evolution of coelom and metamerism. General characteristics and Classification up to classes; Type study of *Pheretima*; Metamerism in Annelids.

Unit2: Arthropoda

15 Lectures

General characteristics and Classification up to classes; Type study of *Periplanata*; Vision and Respiration in Arthropoda; Larval forms in Arthropoda; Metamorphosis in Insects; Social life in bees.

Unit3: Onychophora

05 Lectures

General characteristics and Evolutionary significance with special reference to *Peripatus*.

Unit4: Mollusca

12 Lectures

General characteristics and Classification up to classes; Type study of *Pila*; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves; Evolutionary significance of trochophore larva.

Unit5: Echinodermata

10 Lectures

General characteristics and Classification up to classes; Type study of *Asterias*; Water-vascular system in Asteroidea; Larval forms in Echinodermata; Affinities with Chordates.

Practical

1. Study of following specimens:

Annelids: *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria* etc.

Arthropods: *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta*, termites and honey bees etc.

Onychophora: *Peripatus*

Molluscs: *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus* etc.

Echinoderms: *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon* etc.

2. Study of digestive system of earthworm
3. Study of septal nephridia and pharyngeal nephridia of earthworm
4. T. S. through pharynx, gizzard, and typhlosolar intestine of earthworm
5. Mount of mouth parts and dissection of digestive system of *Periplaneta*
6. Dissection of nervous system of *Periplaneta*
7. To submit a project report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JJ (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
4. Nigam (1997). Biology of Chordates, S. Chand.
5. Kotpal, Modern text book of Zoology: Vertebrates, Rastogi Publication.

Major Courses: ZOUCMJT1 and ZOUCMJL1

Semester	Major Course	Course Title	Credits
III	3	Diversity of Chordates	Theory: 03 Practical: 01

About the course

By the study of diversity of chordates, it would be easy to know about the species of chordates surviving in different ecological areas of world. It would also be very useful that how these species may be harmful or useful for mankind.

Course outcomes

1. To get information about the diversity of chordates
2. To have awareness about the beneficial and harmful chordates
3. To know about the endangered species of chordates
4. To know about the management of chordates
5. To understand how environment helps to acquire adaptation over a long period of time in different animals.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	-	1
CO5	3	3	3	1	3	3	3	-	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction and origin of Chordates

05 Lecture

General characteristics and outline classification, Dipleurula concept and the Echinoderm theory of origin of chordates, Advanced features of vertebrates over protochordates.

Unit2: Protochordata

08 Lectures

General characteristics of Hemichordata, Urochordata and Cephalochordata, Study of larval forms in Protochordates, Retrogressive metamorphosis in Urochordata.

Unit 3: Agnatha and Pisces

10 Lectures

General characteristics and classification of cyclostomes up to orders; General characteristics of Chondrichthyes and Osteichthyes and Classification up to orders, Skin and Scales, Migration, Osmoregulation and Parental care in fishes.

Unit 4: Amphibia and Reptilia

13 Lectures

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms), General characteristics and classification of Amphibia up to orders, Parental care in Amphibians; General characteristics and classification of Reptilia up to orders, Affinities of *Sphenodon*, Poisonous and non-poisonous snakes, Poison apparatus and biting mechanism.

Unit 5: Aves and Mammalia

16 Lectures

General characteristics and classification of Aves up to orders, *Archaeopteryx*- a connecting link; Principles and aerodynamics of flight, Flight adaptations, Migration in birds; General characters and classification of Mammalia up to orders, Affinities of Prototheria, Metatheria, Adaptive radiation in mammals: locomotory appendages.

Practical

1. Study of following specimens:
Protochordata: *Balanoglossus*, *Herdmania*, *Branchiostoma*, Colonial Urochordata; Agnatha and Fishes: *Petromyzon*, *Myxine*, *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Catla*, *Cirrhinus*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*, *Diodon*, *Anabas*, *Flat fish*. Amphibia and Reptilia: *Ichthyophis*, *Necturus*, *Rana*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*, *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus*, Key for Identification of poisonous and non-poisonous snakes. Aves and Mammalia: Study of common birds from different orders, Types of beaks and claws, *Sorex*, *Bat (Insectivorous and Frugivorous)*, *Rattus*, *Funambulus*, *Loris*, *Herpestes*, *Erinaceus*.
2. Sections of *Balanoglossus* through proboscis and branchiogenital regions.
3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide of *Herdmania* spicules
5. Internal ear of *Scoliodon*.
6. Mount of weberian ossicles of *Mystus*/ pecten from Fowl head/Power point.
7. Study of afferent and efferent arteries of fish (*Scoliodon*).

Suggested readings

1. Young JZ (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Darlington PJ. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
3. Hall BK and Hallgrimsson B (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
4. Dorit, Walker and Barnes (1991). Zoology. Brooks Cole; 1 Edition.
5. Nigam (1997). Biology of Chordates, S. Chand.
6. Kotpal : Modern text book of Zoology: Vertebrates, Rastogi Publication.

Major Courses: ZOUCMJT2 and ZOUCMJL2

Semester	Major Course	Course Title	Credits
III	4	Cell Biology	Theory: 03 Practical: 01

About the course

The course provides a detailed insight into basic concepts of cellular structure and function. It also gives an account of the complex regulatory mechanisms that control cell function.

Course outcomes

After successfully completing this course, the students will be able to

1. Understand the functioning of nucleus and extra nuclear organelles
2. Understand the intricate cellular mechanisms involved.
3. Acquire the detailed knowledge of different pathways related to cell signaling and apoptosis thus enabling them to understand the anomalies in cancer.
4. Develop an understanding how cells work in healthy and diseased states and to give a 'health forecast' by analyzing the genetic database and cell information.
5. Understand how tissues are produced from cells in a normal course and about any malfunctioning which may lead to benign or malignant tumor.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	-	1
CO5	3	3	3	1	3	3	3	-	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Overview of Cells and plasma membrane

15 Lectures

Prokaryotic and Eukaryotic cells, Cell Theory, Virus, Viroids, Prions. Various models of plasma membrane, Structure and Function of Plasma Membrane. Transport across membranes: Active and Passive transport, Facilitated transport; Cell junctions: Tight junctions, Gap junctions.

Unit 2: Cellular Organelles and Endomembrane System

12 Lectures

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Peroxisomes, Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemo-osmotic hypothesis.

Unit 3: Cytoskeleton

08 Lectures

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments.

Unit 4: Nucleus

10 Lectures

Structure of and function of Nucleus. Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome). Giant Chromosomes: Polytene and Lampbrush. Structure and types of DNA and RNA.

Unit 5: Cell division and Signaling

12 Lectures

Cell cycle, cell division- mitosis and meiosis. Cell division check points and their regulation. Role of growth factors. 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.

Practical

1. Familiarization with the student's Light and dissecting microscope.
2. Staining of cell and different organelles (nucleus, mitochondria and chromosomes).
3. Permeability of plasma membrane - effect of isotonic, hypertonic solution.
4. Mitosis in onion root tips and permanent slide and chart.
5. Meiosis in grasshopper testis (from slides/photographs provided) and permanent slide.
6. Study of Polytene chromosomes in *Chironomus* larva.
7. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.

Suggested readings

1. Karp (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition, John Wiley and Sons Inc.
2. De Robertis EDP and De Robertis EMF (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper GM and Hausman RE (2009). The Cell: A Molecular Approach. V Edition; ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009). The World of the Cell, VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Albert B, Dennis B, Julian L, Martin R, Keith R and James W (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.
6. Lodish et al (2008). Molecular Cell Biology, Freeman.

Major Courses: ZOUDMJT1 and ZOUDMJL1

Semester	Major Course	Course Title	Credits
IV	5	Microbiology and Parasitology	Theory: 03 Practical: 01

About the course

This is a composite course with remarkable utility and importance. Microbiology being the study of microorganisms such as viruses, bacteria etc., covers theoretical studies and practical proficiency training which may help in their placement at a clinical microbiological laboratory. Parasitology component takes care of the parasites and parasitism, emphasizing the influence of parasites on the ecology and evolution of free living species, and the role of parasites in global, public, health.

Course outcomes

- Carry out common procedures for culturing, purifying and diagnostics of micro-organisms and understand the disease-causing potential of bacteria and viruses.
- Describe the mechanism for transmittance, virulence, and pathogenecity in pathogenic micro-organisms.
- Diagnose the causative agents, describe pathogenesis and treatment for diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc.
- Understand the variation amongst parasites, parasitic invasion in both plants and animals; applicable to medical and agriculture aspects.
- Help to know the stages of the life cycles of the parasites and the respective infective stages. Develop ecological model, know population dynamics of parasite, establishment of parasite population in host body, adaptive radiations and methods adopted by parasite to combat with the host immune system.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	2	3	3	1	1
CO2	3	3	1	-	1	1	3	1	1
CO3	3	2	3	-	1	1	3	1	-
CO4	3	2	1	-	-	-	2	-	-
CO5	3	2	1	-	-	-	2	-	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Microbiology: A brief account of pathogenic bacteria.

13 Lectures

Brief history of microbiology- germ theory of disease, discovery of penicillin. Diversity of microbes- viruses and bacteria. Host pathogen interaction: invasion, antigenic heterogeneity, toxins and enzymes secretions. Kinetics of bacterial growth and staining techniques.

Unit 2: Microbiology: A brief account of pathogenic viruses

13 Lectures

Viral diseases: polio, rabies, hepatitis, influenza, dengue, AIDS, chicken pox, swine flu with emphasis on their causative agents, pathogenesis, diagnosis, prophylaxis. Bacterial diseases caused by *Streptococcus pneumoniae*, *Salmonella typhi*, *Escherichia coli*, *Helicobacter pylori*, *Mycobacterium tuberculosis*, *Vibrio cholerae*. Fungal diseases: Ringworm infection, aspergillosis, candidiasis.

Unit 3: Introduction to Parasitology

13 Lectures

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship, Population dynamics of parasite and establishment of parasite population in host body, evolution of parasitism, evolution and coevolution of parasite with respect to host strategy.

Unit 4: Parasitic Protists and Platyhelminthes

12 Lectures

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*, *Fasciolopsis buski*, *Schistosoma haematobium*, *Taenia solium*.

Unit 5: Parasitic Nematodes and Arthropoda

12 Lectures

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*. Biology, importance and control of ticks, mites, *Pediculus humanus* (Head and Body louse), *Xenopsylla cheopis* and *Cimex lectularius*.

Practical

Practical

1. Study of permanent slides and specimens of parasitic protozoans and helminthes.
2. Pathological examination of sputum, blood, urine and stool.
3. Blood: Erythrocyte Sedimentation Rate (ESR), Haematocrit.
4. Staining and identification of Gram positive and Gram negative bacteria.
5. Preparation of thin and thick blood films to diagnose Plasmodium infections.
6. Preparation of temporary and permanent slides of faecal matter by saline preparation and concentration techniques to identify cysts of parasitic protozoans and helminthes eggs.
7. Group discussion or Seminar presentation on one or two related topics to those provided in the list.
8. Study of life stages of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs.
9. Study of adult and life stages of *Fasciolopsis buski*, *Schistosoma haematobium* and *Taenia solium* through permanent slides/microphotographs.
10. Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/microphotographs.
11. Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs.
12. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as by product]

Recommended readings

1. Jawetz, M. and Adelberg (2015) Medical Microbiology (27th edition)
2. Chatterjee, K.D (2015) Parasitology (13th edition)
3. Goldsby, R.A.; Kindt, T.J. and Kuby, J. (2006) Immunology (6th edition).
4. Roitt, I.; Brostoff, J. and Male, D. (2012) Immunology (8th edition).
5. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors
6. Noble, E.R. and Noble, G.A. (1982) Parasitology: The Biology of Animal Parasites. V Edition, Lea & Febige

Major Courses: ZOUDMJT2 and ZOUDMJL2

Semester	Major Course	Course Title	Credits
IV	6	Fundamental Biochemistry	Theory: 03 Practical: 02

About the course

Course is aimed to provide molecular structure of biological macromolecules (Carbohydrates, protein, and lipids) and their significance in living system. How enzymes work to perform biochemical reaction during metabolism.

Course Outcomes

To analyses and understand the basic concept of chemical reaction occur in living system that enables them to explore the applied science beneficial for mankind.

1. Understand about the importance and scope of biochemistry.
2. Understand the structure and biological significance of carbohydrates, proteins and lipids.
3. Understand the concept of enzyme, its mechanism of action and regulation.
4. Learn biochemical tests for amino acids, carbohydrates, proteins and nucleic acids.
5. Learn measurement of enzyme activity and its kinetics.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	-	1
CO5	3	3	3	1	3	3	3	-	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Biomolecules

04 Lectures

Chemistry of Living system: Scope and importance; Biomolecules: Organizational principle, Configuration and confirmation; Water as a biological solvent.

Unit 2: Carbohydrates

10 Lectures

Structure and Biological importance of carbohydrates. Aldose, ketose, chiral centre, polarized light and Fischer's nomenclature, cyclization reaction of glucose, anomers, pyranose, furanose, glycosidic linkage, reducing and non-reducing sugars. Sequence of reactions and regulation of glycolysis, Citric acid cycle, Pentose Phosphate pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.

Unit 3: Lipids

08 Lectures

Structure and Significance: saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids. β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis.

Unit 4: Proteins

14 Lectures

Proteins: Bonds stabilizing protein structure; Denaturation; Simple and conjugate proteins.

Amino acids: Structure, Classification and properties of α -amino acids; essential and non-essential α -amino acids. Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C- skeleton of Glucogenic and Ketogenic amino acids.

Unit 5: Enzymes

14 Lectures

Nomenclature and classification; Cofactors; Specificity of enzyme action; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max} , Lineweaver-Burk plot; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

Practical

1. Qualitative tests of functional groups in carbohydrates: Benedict's test for reducing sugars, Iodine test for starch
2. Qualitative tests of proteins
3. Qualitative tests of lipids.
4. Paper chromatography of amino acids.
5. Action of salivary amylase under optimum conditions.
6. Effect of pH, temperature and inhibitors on the action of salivary amylase.
7. Structural study of biomolecules through models/ charts/PPT.
8. Preparation and roles of phosphate and bicarbonate buffers.

Suggested reading

1. Cox MM and Nelson DL (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg JM, Tymoczko JL and Stryer L (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Well PA (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
4. Hames BD and Hooper NM (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
5. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

Major Courses: ZOUDMJT3 and ZOUDMJL3

Semester	Major Course	Course Title	Credits
IV	7	Ecosystem Dynamics and Conservation	Theory: 03 Practical: 02

About the course

This course will take students on a journey through the physical workings of the Earth, the interactions between species and their environments. The course highlights on some of the important aspects viz. growth and survival of populations and communities in different habitats, energy flow in the ecosystems, interactions between the communities, exclusion of niches and consequences of changing environment on the biodiversity.

Course outcomes

After successfully completing this course, the students will be able to:

1. Develop knowledge base covering all attributes of the environment and ecology.
2. Illustrate the flow of energy through ecosystems with reference to tropic levels and ecological efficiency.
3. Describe population structures and growth.
4. To develop an appreciation of the modern scope of the scientific study in the field of ecology.
5. Solve the environmental problems involving interaction of humans and natural systems at local or global level. To study about basic methods of wildlife conservation

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Ecology

03 Lectures

History of ecology; Autecology and synecology; Levels of organization; Laws of limiting factors- Liebig's law of minimum and Shelford's law of tolerance; Study of physical factors-Temperature and Light.

Unit 2: Ecosystem

12 Lectures

Types of ecosystems: Trophic levels; Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through ecosystem; Ecological pyramids and Ecological efficiencies; Ecological features of Tundra, Desert, Savannah and Tropical Rain forest Biomes; Human modified ecosystem. Nutrient and biogeochemical cycle (C, N, P & S).

Unit 3: Population

12 Lectures

Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age and sex ratio, dispersal and dispersion, Exponential and logistic growth, equation and patterns, r and k strategies; Population regulation-density-dependent and independent factors; Population interactions.

Unit 4: Community

07 Lectures

Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological Succession, Types of Succession, Theories pertaining to climax community.

Unit 5: Human impact on environment

06 Lectures

Environmental Pollution: Air, water and noise pollution; Greenhouse effect, Acid rain, Global Warming, Ozone depletion. Ecology in Wildlife Conservation and Management, Biodiversity; types, importance and threats. Protected areas; National parks, Bio reserves and Sanctuaries. Restoration ecology.

Practical

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂.
4. To measure microclimatic variables viz., temperature, humidity and light conditions in a microhabitat..
5. Making an ecosystem in a wide-mouthed bottle.
6. Constructing a food web by observing and collecting organisms from a given area.
7. Preparing and clearly present an essay based on the evaluation of 4-7 publications.
8. Studying insect diversity in a habitat.
9. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

Suggested readings

1. Colinvaux P A (1993). Ecology. II Edition. Wiley, John and Sons, Inc.
2. Krebs C J (2001). Ecology. VI Edition. Benjamin Cummings.
3. Odum EP (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole.
4. Robert Leo Smith, Ecology and field biology Harper and Row publisher.
5. Ricklefs RE (2000). Ecology. V Edition. Chiron Press.

Major Courses: ZOUEMJT1 and ZOUEMJL1

Semester	Major Course	Course Title	Credits
V	8	Physiology of Basic Life Processes	Theory: 03 Practical: 02

Course Objective:

To acquaint students with the principles and basic facts of animal physiology in relation with integumentary system, digestion, respiration, renal physiology, blood and physiology of heart to promote student understanding.

Course Outcomes:

To Understand fundamental principles of animal physiology and life sustaining systems.

To understand the processes involved in formation and functioning of integumentary system.

To understand the mechanism of respiration and circulatory physiology in animals.

To understand the processes involved in functioning of digestion and renal physiology in animals.

To gain experience in discussing and answering questions about animal physiology

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	1	1
CO5	3	3	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Integumentary system

8 Lectures

Cell junction, epithelial and connective tissue, structure, type and function of skin, accessory structure of skin.

Unit 2: Digestion

12 Lectures

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in gastrointestinal tract.

Unit 3: Respiration

10 Lectures

Mechanism of breathing and respiration: Pulmonary ventilation; Transport of oxygen and carbon dioxide in blood; Respiratory volumes and capacities; Respiratory pigments, Control of respiration

Unit 4: Excretion

10 Lectures

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

Unit 5: Blood and circulation

10 Lectures

Components of blood and their functions; Structure and functions of hemoglobin Hemostasis: Blood clotting system, Hemopoiesis Blood groups: Rh factor, ABO and MN

Structure of mammalian heart; Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate.

Practical

1. To study structure of skin with the help of chart/model.
2. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, liver and pancreas through permanent slides
3. Determination of ABO Blood group
4. Enumeration of red blood cells and white blood cells using haemocytometer
5. Estimation of haemoglobin using Sahli's haemoglobinometer
6. Preparation of haemin and haemochromogen crystals
7. Recording of frog's heart beat under *in situ* and perfused conditions*
8. Recording of blood pressure using a sphygmomanometer
9. Examination of sections of mammalian lung and kidney through permanent slides.

Suggested readings

1. Guyton AC and Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

Major Courses: ZOUEMJT2 and ZOUEMJL2

Semester	Major Course	Course Title	Credits
V	9	Bioinstrumentation	Theory: 03 Practical: 02

About the course

This is the only laboratory course taught independently of lecture courses. It has full hands on approach to expose the students to modern techniques and methodologies. The diverse techniques from microscopy to spectroscopy, calorimetry, chromatography ELISA, tissue culture to cloning etc. are included to make the student well versed with these protocols and methods.

Learning outcomes

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. Learn the construction repair and adjustment of any equipment required for a technique.
4. Learn the accuracy of technique.
5. Learn the maintenance laboratory equipments/ tools, safety hazards and precautions.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	2	2	2	3	3	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Microscopy

10 Lectures

Microscopy: Introduction to Microscopy. Definitions-Resolving Power, Limit of Resolution and Magnification, Numerical Aperture. Types of microscopes. bright field, dark-field, phase contrast. Basic principles of Light, Electron, Fluorescence and Confocal Microscopy. Measurements, Drawings and photomicrography.

Unit 2: Microtomy & Histology

05 Lectures

Microtomy: Type of microtome, type of blade, ultra-microtome and rotary microtome. Histology: Tissue preparation, fixation, block preparation, sectioning, staining, dehydration and mounting.

Unit 3: Tools and techniques in Biochemistry and Physiology

13 Lectures

Biochemistry and Physiology: Physiological Salines, Buffers and the use of pH meter. Extraction of Tissue Proteins and Nucleic Acids. Subcellular Fractionation by Differential Centrifugation. Basic Principle and Application of Colorimetry and Spectrophotometry, Beer-Lambert's Law. Principle and applications of Electrophoresis: Separation of Biomolecules by Native PAGE, 2D PAGE. Agarose gel electrophoresis. Principle and Applications of Paper chromatography, Thin layer chromatography, Gel-filtration chromatography.

Unit4: Tools and Techniques in Endocrinology and immunology

13 Lectures

Raising Polyclonal and Monoclonal Antibodies. Antigen-Antibody Interactions- Immunodiffusion, Ouchterlony's Double Immunodiffusion, Counter-Current, Immunoelectrophoresis, Western Blotting, ELISA, RIA. Application of Immunological techniques in disease diagnosis. Tracer techniques: Principle and Applications.

Unit 5: Cell culture, maintenance of Laboratory animals

13 Lectures

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, laminar flow. Types of animal cell culture, cell viability testing. cryopreservation. Lymphocyte culture. Cell harvesting and Storage Methods, Maintenance and Handling of laboratory rats and rabbits. Bioethics.

Practical

1. Preparation of buffer and determination of pH.
2. Identification of amino acids in the mixture using paper chromatography.
3. Verification of laws of spectrophotometry.
4. Demonstration of separation of proteins using SDS-PAGE.
5. Tissue fixation, paraffin block preparation, sectioning.
6. Preparation of permanent slides of microscopic organisms/ small insects.
7. Demonstration of bright field, phase contrast, fluorescence, confocal and electron microscopes.

Suggested readings

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.

Major Courses: ZOUEMJT3 and ZOUEMJL3

Semester	Major Course	Course Title	Credits
V	10	Principle of Genetics and Evolution	Theory: 03 Practical: 02

About the course

The course is designed to provide basic concepts of genetics and evolution to students and then move on to advanced concepts. Some key aspects include the mechanism of inheritance, gene structure and function, sex chromosomal and autosomal anomalies, aspects of human genetics, evolutionary concepts, and forces of evolution etc. A strong emphasis will be laid on the modern tools and techniques used in genetics.

Course outcomes

1. Understand the Mendelian inheritance and Gene interactions.
2. Understand the causes of variations.
3. Understand the mechanism of regulation of gene expression.
4. Understand the origin of life and basic evolutionary processes.
5. Discuss and analyze the forces and product of evolution.

Course Outcomes and their mapping with Programme Outcomes

COs	POs					PSOs		
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3
CO1	3	3	2	2	3	3	3	2
CO2	3	3	2	2	3	3	3	2
CO3	3	3	3	2	3	3	3	2
CO4	3	3	2	1	3	3	2	1
CO5	3	3	2	1	3	3	2	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Concept of Genes and Genomics

12 Lectures

Genetics: scope and Elements of heredity and variation: Classical and Modern concept of Gene (Cistron, muton, recon), Mendel's laws of inheritance, Chromosomal basis of inheritance. Exceptions to Mendelian Inheritance: Incomplete dominance, Co-dominance, Multiple allelism, Lethal alleles, Pleiotropy, Epistasis. Penetrance and expressivity, Polygenic inheritance, Sex-linked, sex influenced and sex-limited characters.

Unit 2: The recombination and interaction of Genes

12 Lectures

Linkage and crossing over, Extra-nuclear inheritance, Sex Determination, Genic balance theory, Gene dosage Compensation, Structural and numerical alterations of chromosomes, Genetic traits: Autosomal dominant and autosomal recessive, X-linked dominant, and X-linked recessive.

Unit 3: Regulation of Gene expression and Human Genetics

12 Lectures

One gene-one enzyme hypothesis /one polypeptide hypothesis. Concept of operon, Bacterial transposons. Vertical and horizontal gene transfer. Transformation, transfection and transduction, Genetic complementation, Pedigree analysis; Karyotype, 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).

Unit 4: Origin of Life, Evolutionary Concepts and Evidences of Evolution

10 Lectures

Chemogeny and Biogeny, RNA world, Lamarckism, Darwinism, Neo-Darwinism, Palaeontological evidences: Fossils (formation, types and dating); Geological time scale; Study of horse, Molecular evidences: neutral theory of molecular evolution, Molecular clock

Unit 5: Forces & Product of Evolution

12 Lectures

Hardy-Weinberg Law, Natural selection (concept of fitness, selection coefficient, types of selection, genetic drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies. Micro evolutionary changes (inter-population variations, clines, races, species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution

Practical

1. Application of probability in the law of segregation with coin tossing
2. Frequency of the following genetic traits in human: widow's peak, attached ear lobe, dimple in chin, hypertrichosis, colour blindness, PTC tasting
3. Study of mode of inheritance of the following traits by pedigree charts – attached ear lobe, widow's peak
4. Study of structural chromosome aberrations (dicentric, ring chromosomes and inversions in polytene chromosomes) from prepared slides/photographs
5. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome)
6. Chi-square analyses using seeds/beads/*Drosophila*.
7. *Drosophila* biology: Sexual dimorphism, Life cycle and different mutant's types.
8. Linkage maps based on data from *Drosophila* crosses.
9. Study of fossils from models/pictures
10. Study of homology and analogy from suitable specimens
11. Study and verification of Hardy-Weinberg Law by chi square analysis

Suggested readings

1. Gardner, E.J. et al. (2006) Principles of Genetics (John Wiley).
2. Russell, P.J. (2010) Genetics (Benjamin Cummings).
3. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
4. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
5. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics. (X edition) Benjamin Cummings.
6. Carroll S.B.; Doebley J.; Griffiths, A.J.F. and Wessler, S.R. (2018) An Introduction to Genetic Analysis. W. H. Freeman and Co. Ltd.
7. Ridley, M (2004) Evolution III Edition Blackwell publishing
8. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
9. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin Cummings.
10. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.

Major Courses: ZOUFMJT1 and ZOUFMJJ1

Semester	Major Course	Course Title	Credits
VI	11	Physiology of Regulatory Life Processes	Theory: 03 Practical: 02

About the course

To familiarize students with the principles and basic facts of animal physiology. Emphasis will be placed on control and coordination of tissues, bone and cartilage, muscle and nervous system.

Course outcomes

1. To understand fundamental principles of animal physiology.
2. To understand how these principles are incorporated into to regulate life process.
3. To understand control and coordination of various organ systems in animals i.e. tissues, bone and cartilage, muscle.
4. To understand the working and importance of nervous system in animals.
5. To gain experience in discussing, and answering questions about animal physiology.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit1: Tissues

10 Lectures

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue.

Unit 2: Boneand cartilage

12 Lectures

Structure and types of bones and cartilages, Ossification, bone growth.

Axial skeletal: skull and vertebral column, appendicular skeletal: pectoral and pelvic girdle, limbs, joints.

Unit3: Muscle

08 Lectures

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus.

Unit 4: Nervous system

10 Lectures

Type of nervous tissue: neuron and glia; Structure of brain, cerebrospinal fluid, neural network, cranial nerves, blood brain barrier, spinal cord anatomy, spinal nerves.

Unit 5: Electrical signal in neurons

10 Lectures

Axonal and synaptic transmission: Membrane potential and action potential; Types of synapses and synaptic knobs; Excitatory and inhibitory post-synaptic potential; Chemical transmission; Neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides.

Practical

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Study of tissues of various kind with model, chart/PPT.
3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
4. Study of Axial skeletal: skull
5. Study of Axial skeletal: Vertebral column
6. Study of appendicular skeletal: Pectoral and pelvic girdle
7. Study of appendicular skeletal: Limbs.
8. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
9. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell.
10. Microtomy: Preparation of permanent slide of mammalian tissues

Suggested readings

1. Guyton AC and Hall JE (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora GJ and Grabowski S (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons
3. Victor P Eroschenko (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Major Courses: ZOUFMJT2 and ZOUFMJL2

Semester	Major Course	Course Title	Credits
VI	12	Element of Molecular Biology	Theory: 03 Practical: 02

About the course

The course provides an insight into the life processes at the subcellular and molecular levels. Other important aspects include DNA and molecular genetics including gene cloning, sequencing and gene mapping in addition to the powerful techniques that revolutionized the pharmaceutical, health and agricultural industries.

Learning outcomes

1. Develop an understanding of concepts, mechanisms and evolutionary significance and relevance of molecular biology in the current scenario.
2. Get well versed in recombinant DNA technology which holds application in biomedical & genomic science, agriculture, environment management, etc. Therefore, a fundamental understanding of Molecular Biology will help in career building in all these fields.
3. Apply their knowledge in problem solving and future course of their career development in higher education and research.
4. Get new avenues of joining research in related areas such as therapeutic strategies or related opportunities in industry.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	3	3	2	3
CO2	3	3	2	2	2	3	3	2	3
CO3	3	3	2	2	2	3	3	2	3
CO4	3	3	2	2	2	3	3	2	3
CO5	3	3	2	2	2	3	3	2	3

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Nucleic Acids

10 Lectures

Salient features of DNA and RNA Watson and Crick model of DNA; Ribosomes, Different types of RNAs

Unit 2: DNA Replication

12 Lectures

DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear *ds*-DNA, replication of telomeres, Concept of DNA repairing

Unit3: Transcription

14 Lectures

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors. Post Transcriptional Modifications and Processing of RNA: Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, Processing of tRNA

Unit4: Translation

12 Lectures

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference in prokaryotic and eukaryotic translation

Unit 5: Gene Regulation

12 Lectures

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, Genetic imprinting; RNA interference.

Practical

1. Preparation of ball and stick model for B-DNA molecule (A=T and G=C base pairs).
2. Isolation of genomic DNA by ethanol precipitation method.
3. Demonstration of preparation of LB-agar plates (with and without 100 microgram/ml Ampicillin and 10 microgram/ml Tetracycline), streaking of E. coli DH5alpha strain (normal) and transformed with plasmids [Ampicillin-resistant (pBluescript) and Tetracycline resistant (pBR322)].
4. Demonstration of isolation of the plasmid DNA from the E. coli culture by alkaline lysis method.
5. Demonstration of agarose gel electrophoresis of the plasmid DNA and the genomic DNA.
6. Demonstration of staining of β -galactosidase activity in the DH5alpha cells with pBluescript plasmid by IPTG+X-Gal as an example of induction of gene expression.

Suggested readings

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.

Major Courses: ZOUFMJT3 and ZOUFMJL3

Semester	Major Course	Course Title	Credits
VI	13	Reproductive and Developmental Biology	Theory: 03 Practical: 02

Course Outcome

The course inculcates the knowledge and understanding of formation of gametes and reproductive processes in mammals. Student will learn the anatomy and function of male and female reproductive systems and accessory glands. The teaching will also aid in the understanding of fertilization (external and internal), embryonic development and post embryonic development.

Learning Outcomes

- Major objective is to provide student with a sound coverage of mammalian reproductive biology with in framework of human biology.
- Study will be achieved by learning fundamental of structure and function of male and female reproductive tract.
- Gametogenesis, fertilization early embryonic fetal development till birth of young one will be focused.
- It will provide important function to consider sexual differentiation and development.
- Aspects of infertility and current reproductive technology will be inculcated.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	1	3	-	-
CO2	3	3	1	-	-	1	3	-	-
CO3	3	3	2	-	-	3	3	2	2
CO4	3	2	1	-	-	2	3	1	2
CO5	3	1	3	1	-	3	3	3	2

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Male reproductive system

10 Lectures

Outline and histology of male reproductive system in human; Testis: Cellular functions, germ cell; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract.

Unit 2: Functional anatomy of female reproduction

12 Lectures

Reproductive cycles (rat and human) and their hormonal regulation, changes in the female tract; Outline and histology of female reproductive system in human; Ovary: folliculogenesis ovulation, corpus luteum formation and regression; secretion of ovarian hormones.

Unit 3: Gamete Biology and Fertilization

12 Lectures

Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Oogenesis, Hormonal regulation of Oogenesis, Steroidogenesis Pathway and regulation; Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Sperm egg interaction; Changes in gametes, Blocks to polyspermy.

Unit 4: Early and Late Embryonic Development

12 Lectures

Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers; Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta).

Unit 5: Post Embryonic Development

10 Lectures

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphic regeneration of Salamander limbs, morphallactic regeneration in *Hydra* and compensatory regeneration in mammalian liver; Ageing: concept and theories.

Practical

1. Study of animal house: set up and maintenance of animal house, care of normal and experimental animals.
2. Examination of vaginal smear rats from live animals.
3. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
4. Human vaginal exfoliate cytology.
5. Sperm count and sperm motility in rat
6. Study of modern contraceptive devices
7. Mini projects involving survey, data collection, statistical analysis, and submission of a project report on reproductive health of a small human population.
8. Collection, preparation and Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)
9. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
10. Window preparation to study chick embryo development
11. Study of different sections of placenta (photomicrograph/slides)
12. Project report on *Drosophila* culture/chick embryo development
13. A visit to Poultry farm/IVF centre

Suggested readings

1. Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
2. Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
3. Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
4. Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.
5. Gilbert, S. F. (2016). Developmental Biology, XIth Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
6. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
7. Carlson, R. F. Patten's Foundations of Embryology
8. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw- Hill Publishers
9. Lewis Wolpert (2019). Principles of Development. VI Edition, Oxford University Press

I. Course structure for UG (Honours with Research)

Major Courses: ZOUGMJT1 and ZOUGMJL1

Semester	Major Course	Course Title	Credits
VII	14	Immunology	Theory: 03 Practical: 02

Course Outcome

- To provide knowledge on essential features of antigens and antibodies and their types.
- To acquire knowledge on types of immunity, phagocytosis, interferons and complement system.
- To explain the concept of different types of hypersensitivity, and transplantation.
- To provide knowledge on immune deficiencies and several immunological techniques.

Learning Outcomes

1. Gain knowledge on essential features of different types of antigens, antibodies.
2. Out line, compare and contrast the key mechanism of innate and adaptive immunity.
3. Gain knowledge on undesirable immunological reactions and their complications in health management and transplantation.
4. Apply knowledge in disease diagnosis through serological tests.
5. Understand the autoimmune diseases and techniques in immunology.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	3	2	1
CO2	3	3	2	2	1	1	3	2	1
CO3	3	3	1	2	1	3	3	3	2
CO4	3	2	1	2	-	2	3	2	-
CO5	3	2	-	1	-	3	3	1	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Immunology: Immune mechanism and related pathways

12 Lectures

Scope of Immunology, Historical background of Immunology, Biological aspects of Immunology, Self and non-self-recognition, specificity, memory of immune system. Cells and organs of immune system- primary and secondary lymphoid organs. Innate immunity: First and second lines of defense.

Unit 2: Antigen-antibody Interaction

13 Lectures

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, alternative and lectin pathways).

Unit 3: Acquired immunity

13 Lectures

Acquired immunity: 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 function. MHC complex and molecules with classification and function.

Unit 4: Hypersensitivity and Disorders of Immune System

13 Lectures

Types, clinical diseases. Blood groups: AB, Rh system, Lewis-Luthern systems, significance, Erythroblastosis foetalis. Auto immunity: Introduction, Auto recognition, classes of auto immune diseases. Transplantation: Terminology, Auto graft, Isograft, Allograft, Xenograft, Immunological basis of transplantation reactions, GVH reaction, Immuno suppression, General mechanisms of Immune suppression, Immune suppression, drugs (azathioprine, methotrexate, cyclophosphamide, cyclosporin-A, Steroids).

Unit 5: Immunological techniques

12 Lectures

Hybridoma technology, monoclonal antibodies, immunotoxins. Radioimmunoassay: ELISA – Principle, Methodology and applications. Immuno-fluorescence: Direct, indirect and Sandwich, *in situ* localization by techniques such as FISH and GISH.

Practical

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/photographs.
3. Preparation of stained blood film to study various types of blood cells.
4. ABO Blood group antigen determination by heamagglutination.
6. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of:
 - (a) ELISA
 - (b) Immunoelectrophoresis
8. Detection of complement activity using haemolysis of antibody coated SRBC and standard Serum.
9. Demonstration of antigen-antibody interaction in gel.
10. Separation of γ -globulin by salt precipitation.
11. Group discussion or Seminar presentation on one or two related topics to those provided in the list.

Recommended Books:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006). Immunology, VI Edition, W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
3. Essential immunology- Ivan M. Roitt.
4. Introduction to Immunology – John W. Kinball.
5. Immunology – D. M. Weir.

Major Courses: ZOUGMJT2 and ZOUGMJL

Semester	Major Course	Course Title	Credits
VII	15	Endocrinology	Theory: 03 Practical: 02

About the course

The course envisages information on endocrine system with emphasis on the structure of hypothalamus and anterior pituitary. The associated hormones and the related disorders will be explained.

Learning outcomes

- Understand neurohormones and neurosecretions.
- Learn about hypothalamo-hypophyseal axis.
- Understand about different endocrine glands.
- Understand about different endocrinopathies.
- Understand the mechanism of hormone action.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	-	2	-	3	2	-
CO2	3	3	2	-	1	-	3	2	-
CO3	3	2	2	-	3	-	3	3	-
CO4	3	3	3	-	2	-	3	3	-
CO5	3	2	1	-	2	-	3	3	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit-I: The chemical messengers

07 Lectures

Definition and classification of hormones. Endocrine, paracrine and autocrine modes of hormone delivery, Feedback mechanism, Types of hormones, protein and steroid hormone.

Unit II: Hypothalamo-hypophyseal Axis

10 Lectures

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction; Structure of hypothalamus, Hypothalamic nuclei and their functions; Regulation of neuroendocrine glands, Feedback mechanisms; Structure of pituitary gland, Its hormones and their functions; Hypothalamo-hypophyseal portal system; Disorders of pituitary gland.

Unit-III: Peripheral Endocrine Glands

20 Lectures

Structure, Hormones, Functions, Synthesis and Regulation of Thyroid gland; Parathyroid and Adrenal glands; Pancreas; Ovary and Testis; Hormones in homeostasis; Disorders of endocrine glands.

Unit-III: Evolution of reproductive mechanism and regulation

05 Lectures

Evolution of human reproductive strategy; Evolutionary impact on behaviour; Sexuality hormonal effects on maternal-infant bonding; Parturition; Stress, anorexia, steroids in the environment; Endocrine disrupting chemicals.

Unit-IV: Regulation of Hormone Action

10 Lectures

Hormone action at Cellular level: Hormone receptors; Membrane and intracellular receptors, Transduction and regulation of Hormone action at Molecular level; Molecular mediators; Genetic control of hormone action.

Practical

1. Dissection and demonstration of Endocrine glands in laboratory bred rat*.
2. Study of the permanent slides of all the endocrine glands.
3. Compensatory ovarian/ adrenal hypertrophy in vivo bioassay in laboratory bred rat*.
4. Demonstration of Castration/ ovariectomy in laboratory bred rat*.
5. Estimation of plasma level of any hormone using ELISA.
6. Designing of primers of any hormone.
7. Group discussion or Seminar presentation on one or two related topics from the list

Recommended readings

1. Turner, C. D. (1971) General Endocrinology, Pub- Saunders Toppan.
2. Nussey, S.S.; and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.
3. Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.
4. David, O.N. (2013) Vertebrate Endocrinology.

Major Courses: ZOUGMJT3 and ZOUGMJL3

Semester	Major Course	Course Title	Credits
VII	16	Toxicology	Theory: 03 Practical: 02

About the course

This course is focused on theoretical and applied knowledge on the effects of chemical substances on human health. The students will also get introduced to the toxicological analysis and the signs and symptoms of important toxic syndromes. The students will also study the basic toxicokinetic principles and metabolic systems to elucidate mechanisms of toxicity induced by xenobiotic compounds.

Learning outcomes

1. Learn basic principles and applications of toxicology.
2. To understand role of xenobiotics in human health
3. Examine the application how xenobiotics disrupt normal cellular processes of genomics, proteomics, and metabolomics data
4. Understand mechanisms of systemic and organ toxicity induced by xenobiotics; and learn how to analyze and interpret complex data sets in toxicological research and deliver a scientific presentation.
5. Use clinical and laboratory findings in the treatment of acute toxic exposures

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	1	1
CO5	3	3	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Basic concept of toxicology

10 Lectures

Introduction of toxicology, history and scope of toxicology, definition of toxicology, different areas of modern toxicology, classification of toxicants. Toxicity of herbal and dietary supplements.

Unit 2: Toxic exposure and response

10 Lectures

Effect of duration, frequency, route and site of exposure of xenobiotics. Various types of dose response relationships: dose-time effect relationship, dose and concentration, dose response curve; Graded responses; Receptor theory; LD50, LC50, TD50 and therapeutic index.

Unit 3: Fate of xenobiotics in animal body

10 Lectures

Absorption, Distribution, Metabolism (Phase- I and phase II reactions) and Excretion of xenobiotics; Bioaccumulation and biomagnifications. Tolerance and addiction.

Unit 4: Pesticides toxicity

10 Lectures

Pesticides and their toxicological effects. Generation of pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides Insecticides, Mode of action of Insecticide.

Unit 5: Metal toxicity

10 Lectures

General principal of metal toxicity, sources, toxic metals and their toxicity. Arsenic, Aluminium, Cadmium, Chromium Lead, Mercury, Manganese, Zinc and Nickel.

Practical

1. To study the structure and function of toxins.
2. Quantitative identification of functional groups in given sample.
3. Qualitative identification of functional groups in given sample.
4. Training on different routes of drug administration (Oral, I.M., I.P, SC.)
5. Calculation of LD50/LC50 by given data.
6. Calculation of therapeutic index by given data.
7. Collection of blood / urine / feces samples from rats/mice.
8. Demonstration of choloretic activity of xenobiotics (virtual lab).
9. Histopathological effects of metal on liver tissues
10. Demonstration of toxic effects of various xenobiotics using computer simulation programs/virtual
11. Preparation of report on any topic of choice on occupational and /or environmental toxicity.

Recommended readings

1. Williams, P.L.; James, R. C. Roberts, S.M. (2003) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, Inc.
2. Klaassen, C. (2007) Casarett and Doull's Toxicology The basic science of poisons – McGraw-Hill.
3. Duffs, J. and Worth, H. (2006) Fundamental Toxicology, RSC Publishing.
- on of plasma level of any hormone using ELISA.
6. Designing of primers of any hormone.
7. Group discussion or Seminar presentation on one or two related topics from the list.

Major Courses: ZOUHMT1 and ZOUHML1

Semester	Major Course	Course Title	Credits
VIII	17	Research Methodology and Biostatistics	Theory: 03 Practical: 02

About the course

The course to introduce students to the important aspects of research and statistics in biology. The course covers all the conceptual and methodological issues that go into successful conduction of research. That includes philosophy of science, the methodological issues in measurement, proposing and testing hypotheses, scientific communication and the ethical issues in the practice of science. It also provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. By going through this course, students are likely to be able to take up research activities in a more systematic and formal manner right from the beginning.

Learning outcomes

1. Students will understand research types, processes, ethics, and develop critical analysis skills.
2. Students will comprehend research design, problem formulation, literature review, objectives, and variables.
3. Students will master research report types, structure, writing, and audience considerations.
4. Students will learn data representation, probability distributions, and statistical measures comprehensively.
5. Students will analyze correlations, regression, ANOVA, and perform hypothesis testing effectively.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	1	1
CO2	3	2	1	1	2	2	3	1	1
CO3	3	2	2	1	2	2	3	1	1
CO4	3	2	3	1	3	3	3	1	1
CO5	3	2	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Basics of Research:

12 Lectures

Meaning, objectives and motivations in research, Characteristics and limitations of research, Components of research work, Criteria of good research, Research process, Types of Research, Fundamental, Pure or Theoretical Research, Applied Research, Descriptive Research, Evaluation Research, Experimental Research, Survey Research, Qualitative Research, Quantitative Research, Historical Research. Ethical issues in research: Code of Ethics in Research, Ethics and Research Process, Importance of Ethics in Research.

Unit 2: Research Designs:

12 Lectures

Research Design, definition, essentials and types of research design, errors and types of errors in research design. Research problem: Selecting and analyzing the research problem, problem statement formulation, formulation of hypothesis. Literature review: purpose, sources, and importance, literature review procedure. Objectives: Learning Objectives; Definitions; Formulation of the research objectives. Variables in Research, Measurement and scaling, Different scales, Construction of instrument, Validity and Reliability of instrument.

Unit 3: Research Report Writing:

8 Lectures

Research report, Different types, Contents of report, executive summary, chapterization, contents of chapter, report writing, the role of audience, readability, comprehension, tone, final proof, report format, title of the report.

Unit 4: Data collection and processing for authentication and analysis

10 Lectures

Collection and classification of data. Graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon. Cumulative frequency curve (Ogive), Box plot. Probability theory: Binomial distribution, Poisson distributions. Measures of central tendency: Arithmetic Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient of variation.

Unit 5: Correlation regression and analysis of variance etc.**10 Lectures**

Correlation: Types of correlation, Calculation of correlation in continuous data and ordinal data. Regression: Linear regression, regression coefficient. Analysis of variance (ANOVA): One way, post-hoc tests. Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, F-test) & Non Parametric tests (Chi-square test, Mann-Whitney U-test)

Practical

1. Designing research frameworks and identifying variables.
2. Preparing and validating survey instruments (e.g., questionnaires, interviews).
3. Graphical representation of data (Pie charts, Bar diagrams, Histograms, Ogives, Box plots).
4. Demonstration of reference formatting (e.g., Endnote, Mendeley, Zotero).
5. Proofreading research paper
6. Calculation of mean, standard deviation and standard error.
7. Student's t-test: Independent and dependent. Hand calculation and calculation using MS Excel.
8. Conducting Analysis of Variance (ANOVA) and post-hoc tests.
9. Calculation of correlation coefficient values and finding out the probability
10. Calculation of 'F' value and finding out the probability value for the F value.

Recommended readings

1. Daniel, W.W. (2012) Biostatistics: A Foundation for Analysis in Health Sciences (10th edition) John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition) McGraw Hill.
3. Zar, J.H. (2013) Biostatistical Analysis (5th edition) Pearson.
4. Kothari, C.R., (2004). Research methodology: Methods and techniques. New Age International.
5. Coolican, H. (2004). Research methods and Statistics in Psychology. London: Hodder Arnold Kerlinger, N. (1996). Foundations of behavioural research. India: Prentice Hall

II. Course structure for UG (Honours)

Major Courses: ZOUGMJT1 and ZOUGMJL1

Semester	Major Course	Course Title	Credits
VII	14	Immunology	Theory: 03 Practical: 02

Course Outcome

To provide knowledge on essential features of antigens and antibodies and their types.
To acquire knowledge on types of immunity, phagocytosis, interferons and complement system.
To explain the concept of different types of hypersensitivity, and transplantation.
To provide knowledge on immune deficiencies and several immunological techniques.

Learning Outcomes

1. Gain knowledge on essential features of different types of antigens, antibodies.
2. Out line, compare and contrast the key mechanism of innate and adaptive immunity.
3. Gain knowledge on undesirable immunological reactions and their complications in health management and transplantation.
4. Apply knowledge in disease diagnosis through serological tests.
5. Understand the autoimmune diseases and techniques in immunology.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	3	2	1
CO2	3	3	2	2	1	1	3	2	1
CO3	3	3	1	2	1	3	3	3	2
CO4	3	2	1	2	-	2	3	2	-
CO5	3	2	-	1	-	3	3	1	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Immunology: Immune mechanism and related pathways

12 Lectures

Scope of Immunology, Historical background of Immunology, Biological aspects of Immunology, Self and non-self-recognition, specificity, memory of immune system. Cells and organs of immune system- primary and secondary lymphoid organs. Innate immunity: First and second lines of defense.

Unit 2: Antigen-antibody Interaction

13 Lectures

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, alternative and lectin pathways).

Unit 3: Acquired immunity

13 Lectures

Acquired immunity: 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 function. MHC complex and molecules with classification and function.

Unit 4: Hypersensitivity and Disorders of Immune System

13 Lectures

Types, clinical diseases. Blood groups: AB, Rh system, Lewis-Luthern systems, significance, Erythroblastosis foetalis. Auto immunity: Introduction, Auto recognition, classes of auto immuno diseases. Transplantation: Terminology, Auto graft, Isograft, Allograft, Xenograft, Immunological basis of transplantation reactions, GVH reaction, Immuno suppression, General mechanisms of Immune suppression, Immune suppression, drugs (azothioprine, methotrexate, cyclophosphamide, cycosporin-A, Steroids).

Unit 5: Immunological techniques

12 Lectures

Hybridoma technology, monoclonal antibodies, immunotoxins. Radioimmunoassay: ELISA – Principle, Methodology and applications. Immuno-fluorescence: Direct, indirect and Sandwich, *in situ* localization by techniques such as FISH and GISH.

Practical

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/photographs.
3. Preparation of stained blood film to study various types of blood cells.
4. ABO Blood group antigen determination by heamagglutination.
6. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of:
 - (a) ELISA
 - (b) Immuno-electrophoresis
8. Detection of complement activity using haemolysis of antibody coated SRBC and standard Serum.
9. Demonstration of antigen-antibody interaction in gel.
10. Separation of γ -globulin by salt precipitation.
11. Group discussion or Seminar presentation on one or two related topics to those provided in the list.

Recommended Books:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006). Immunology, VI Edition, W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
3. Essential immunology- Ivan M. Roitt.
4. Introduction to Immunology – John W. Kinball.
5. Immunology – D. M. Weir.

Major Courses: ZOUGMJT2 and ZOUGMJL

Semester	Major Course	Course Title	Credits
VII	15	Endocrinology	Theory: 03 Practical: 02

About the course

The course envisages information on endocrine system with emphasis on the structure of hypothalamus and anterior pituitary. The associated hormones and the related disorders will be explained.

Learning outcomes

- Understand neurohormones and neurosecretions.
- Learn about hypothalamo-hypophyseal axis.
- Understand about different endocrine glands.
- Understand about different endocrinopathies.
- Understand the mechanism of hormone action.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	-	2	-	3	2	-
CO2	3	3	2	-	1	-	3	2	-
CO3	3	2	2	-	3	-	3	3	-
CO4	3	3	3	-	2	-	3	3	-
CO5	3	2	1	-	2	-	3	3	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: The chemical messengers

08 Lectures

Definition and classification of hormones. Endocrine, paracrine and autocrine modes of hormone delivery, Feedback mechanism, Types of hormones, protein and steroid hormone.

Unit 2: Hypothalamo-hypophyseal Axis

12 Lectures

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction; Structure of hypothalamus, Hypothalamic nuclei and their functions; Regulation of neuroendocrine glands, Feedback mechanisms; Structure of pituitary gland, Its hormones and their functions; Hypothalamo-hypophyseal portal system; Disorders of pituitary gland.

Unit 3: Peripheral Endocrine Glands

12 Lectures

Structure, Hormones, Functions, Synthesis and Regulation of Thyroid gland; Parathyroid and Adrenal glands; Pancreas; Hormones in homeostasis; Disorders of endocrine glands.

Unit 4: Gonadal hormones: Structure of mammalian testis and ovary; Spermatogenesis and structure of sperm; Physiological role of androgens; Oogenesis and structure of egg; Steroid hormone biosynthetic pathways; Ovary: organization and physiological role of estrogen, progesterone, relaxin and inhibin; Estrous and menstrual cycle; Hormones of pregnancy; Parturition; Hormonal control of lactation.

Unit 5: Regulation of Hormone Action

10 Lectures

Hormone action at Cellular level: Hormone receptors; Membrane and intracellular receptors, Transduction and regulation of Hormone action at Molecular level; Molecular mediators; Genetic control of hormone action.

Practical

1. Dissection and demonstration of Endocrine glands in laboratory bred rat*.
2. Study of the permanent slides of all the endocrine glands.
3. Compensatory ovarian/ adrenal hypertrophy in vivo bioassay in laboratory bred rat*.
4. Demonstration of Castration/ ovariectomy in laboratory bred rat*.
5. Estimation of plasma level of any hormone using ELISA.
6. Designing of primers of any hormone.
7. Group discussion or Seminar presentation on one or two related topics from the list

Recommended readings

1. Turner, C. D. (1971) General Endocrinology, Pub- Saunders Toppan.
2. Nussey, S.S.; and Whitehead, S.A. (2001) Endocrinology: An Integrated Approach, Oxford: BIOS Scientific Publishers.
3. Hadley, M.E. and Levine J.E. (2007) Endocrinology (6th edition) Pearson Prentice-Hall, New Jersey.
4. David, O.N. (2013) Vertebrate Endocrinology.

Major Courses: ZOUGMJT3 and ZOUGMJL3

Semester	Major Course	Course Title	Credits
VII	16	Toxicology	Theory: 03 Practical: 02

About the course

This course is focused on theoretical and applied knowledge on the effects of chemical substances on human health. The students will also get introduced to the toxicological analysis and the signs and symptoms of important toxic syndromes. The students will also study the basic toxicokinetic principles and metabolic systems to elucidate mechanisms of toxicity induced by xenobiotic compounds.

Learning outcomes

6. Learn basic principles and applications of toxicology.
7. To understand role of xenobiotics in human health
8. Examine the application how xenobiotics disrupt normal cellular processes of genomics, proteomics, and metabolomics data
9. Understand mechanisms of systemic and organ toxicity induced by xenobiotics; and learn how to analyze and interpret complex data sets in toxicological research and deliver a scientific presentation.
10. Use clinical and laboratory findings in the treatment of acute toxic exposures

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	1	1
CO5	3	3	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Basic concept of toxicology

10 Lectures

Introduction of toxicology, history and scope of toxicology, definition of toxicology, different areas of modern toxicology, classification of toxicants. Toxicity of herbal and dietary supplements.

Unit 2: Toxic exposure and response

10 Lectures

Effect of duration, frequency, route and site of exposure of xenobiotics. Various types of dose response relationships: dose-time effect relationship, dose and concentration, dose response curve; Graded responses; Receptor theory; LD50, LC50, TD50 and therapeutic index.

Unit 3: Fate of xenobiotics in animal body

10 Lectures

Absorption, Distribution, Metabolism (Phase- I and phase II reactions) and Excretion of xenobiotics; Bioaccumulation and biomagnifications. Tolerance and addiction.

Unit 4: Pesticides toxicity

10 Lectures

Pesticides and their toxicological effects. Generation of pesticides: organophosphates, carbamates, organochlorine, bipyridyl compounds and anticoagulant pesticides Insecticides, Mode of action of Insecticide.

Unit 5: Metal toxicity

10 Lectures

General principal of metal toxicity, sources, toxic metals and their toxicity. Arsenic, Aluminium, Cadmium, Chromium Lead, Mercury, Manganese, Zinc and Nickel.

Practical

1. To study the structure and function of toxins.
2. Quantitative identification of functional groups in given sample.
3. Qualitative identification of functional groups in given sample.
4. Training on different routes of drug administration (Oral, I.M., I.P, SC.)
5. Calculation of LD50/LC50 by given data.
6. Calculation of therapeutic index by given data.
7. Collection of blood / urine / feces samples from rats/mice.
8. Demonstration of choloretic activity of xenobiotics (virtual lab).
9. Histopathological effects of metal on liver tissues
10. Demonstration of toxic effects of various xenobiotics using computer simulation programs/virtual
11. Preparation of report on any topic of choice on occupational and /or environmental toxicity.

Recommended readings

1. Williams, P.L.; James, R. C. Roberts, S.M. (2003) Principles of Toxicology: Environmental and Industrial Applications, John Wiley & Sons, Inc.
2. Klaassen, C. (2007) Casarett and Doull's Toxicology The basic science of poisons – McGraw-Hill.
3. Duffs, J. and Worth, H. (2006) Fundamental Toxicology, RSC Publishing.
- on of plasma level of any hormone using ELISA.
6. Designing of primers of any hormone.
7. Group discussion or Seminar presentation on one or two related topics from the list.

Major Courses: ZOUHMT1 and ZOUHML1

Semester	Major Course	Course Title	Credits
VIII	17	Research Methodology and Biostatistics	Theory: 03 Practical: 02

About the course

The course to introduce students to the important aspects of research and statistics in biology. The course covers all the conceptual and methodological issues that go into successful conduction of research. That includes philosophy of science, the methodological issues in measurement, proposing and testing hypotheses, scientific communication and the ethical issues in the practice of science. It also provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. By going through this course, students are likely to be able to take up research activities in a more systematic and formal manner right from the beginning.

Learning outcomes

After completing this course the

6. Students will understand research types, processes, ethics, and develop critical analysis skills.
7. Students will comprehend research design, problem formulation, literature review, objectives, and variables.
8. Students will master research report types, structure, writing, and audience considerations.
9. Students will learn data representation, probability distributions, and statistical measures comprehensively.
10. Students will analyze correlations, regression, ANOVA, and perform hypothesis testing effectively.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	1	1
CO2	3	2	1	1	2	2	3	1	1
CO3	3	2	2	1	2	2	3	1	1
CO4	3	2	3	1	3	3	3	1	1
CO5	3	2	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Basics of Research:

12 Lectures

Meaning, objectives and motivations in research, Characteristics and limitations of research, Components of research work, Criteria of good research, Research process, Types of Research, Fundamental, Pure or Theoretical Research, Applied Research, Descriptive Research, Evaluation Research, Experimental Research, Survey Research, Qualitative Research, Quantitative Research, Historical Research. Ethical issues in research: Code of Ethics in Research, Ethics and Research Process, Importance of Ethics in Research.

Unit 2: Research Designs:

12 Lectures

Research Design, definition, essentials and types of research design, errors and types of errors in research design. Research problem: Selecting and analyzing the research problem, problem statement formulation, formulation of hypothesis. Literature review: purpose, sources, and importance, literature review procedure. Objectives: Learning Objectives; Definitions; Formulation of the research objectives. Variables in Research, Measurement and scaling, Different scales, Construction of instrument, Validity and Reliability of instrument.

Unit 3: Research Report Writing:

8 Lectures

Research report, Different types, Contents of report, executive summary, chapterization, contents of chapter, report writing, the role of audience, readability, comprehension, tone, final proof, report format, title of the report.

Unit 4: Data collection and processing for authentication and analysis

10 Lectures

Collection and classification of data. Graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon. Cumulative frequency curve (Ogive), Box plot. Probability theory: Binomial

distribution, Poisson distributions. Measures of central tendency: Arithmetic Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient of variation.

Unit 5: Correlation regression and analysis of variance etc.

10 Lectures

Correlation: Types of correlation, Calculation of correlation in continuous data and ordinal data. Regression: Linear regression, regression coefficient. Analysis of variance (ANOVA): Oneway, post-hoc tests. Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, F-test) & Non Parametric tests (Chi-square test, Mann-Whitney U-test)

Practical

11. Designing research frameworks and identifying variables.
12. Preparing and validating survey instruments (e.g., questionnaires, interviews).
13. Graphical representation of data (Pie charts, Bar diagrams, Histograms, Ogives, Box plots).
14. Demonstration of reference formatting (e.g., Endnote, Mendeley, Zotero).
15. Proofreading research paper
16. Calculation of mean, standard deviation and standard error.
17. Student's t-test: Independent and dependent. Hand calculation and calculation using MS Excel.
18. Conducting Analysis of Variance (ANOVA) and post-hoc tests.
19. Calculation of correlation coefficient values and finding out the probability
20. Calculation of 'F' value and finding out the probability value for the F value.

Recommended readings

1. Daniel, W.W. (2012) Biostatistics: A Foundation for Analysis in Health Sciences (10th edition) John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition) McGraw Hill.
3. Zar, J.H. (2013) Biostatistical Analysis (5th edition) Pearson.
4. Kothari, C.R., (2004). Research methodology: Methods and techniques. New Age International.
5. Coolican, H. (2004). Research methods and Statistics in Psychology. London: Hoddes Arnold Kerlinger, N. (1996). Foundations of behavioural research. India: Prentice Hall

Major Courses: ZOUHMT2 and ZOUHML2

Semester	Major Course	Course Title	Credits
VIII	18	Applied Zoology	Theory: 03 Practical: 02

About the course

The course is unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/ methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.

Learning outcomes

1. Understanding the culture techniques of prawn, pearl and fish.
2. Understanding the silkworms rearing.
3. Understand the bee keeping, equipments used and apiary management.
4. Understand dairy animals management, the breeds and diseases of cattle and learn about the milk quality.
5. To understand about the poultry birds and their management.
6. Learn various concepts of lac cultivation.
7. To learn the vermi-composting and vermi-wash preparation and their importance in crop production.
8. Be aware of a broad array of career options and activities in human medicine, biomedical research and allied health professions.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	1	1
CO5	3	3	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Aquaculture

13 Lectures

Prawn culture: Culture of fresh water and marine prawn; Preparation of farm. Preservation and processing of prawn. Pearl Culture: Technique of pearl culture; Types and chemical composition of pearl. Fish Culture: Major carps; Ponds of fish culture. Composite fish culture. Induced breeding. Transportation of fish seeds. Preservation of fish. By products of fish. Fish diseases.

Unit 2: Apiculture, Lac culture and Sericulture

13 Lectures

Apiculture: Bee species and caste. Life history of *Apis*. Social organization of honey bee. Methods of Bee keeping. Bee products and their uses. Diseases and their control measures. Lac culture: Lac insect and its life cycle. Host plants and cultivation of lac insect. Processing of raw lac. Chemical composition and uses of lac. Sericulture: Types of silkworms, silk and their host plants; Life history of silkworm; Mulberry silkworm culture; Natural enemies and diseases and their control.

Unit 3: Dairy management

05 Lectures

Introduction to common dairy animals (cow and buffalo). Morphological characteristics of cow. Techniques of dairy management: Housing, feeding and breeding management. Transportation of milk. Cattle diseases.

Unit 4: Poultry farming

08 Lectures

Breeds of fowl. Housing and Equipments, Rearing technology: Deep litter and cage system; Management of growers, Layers, Broilers; Feed formulations for chicks, Debeaking. Egg collection and preservation. Diseases of fowl.

Unit 5: Vermi-culture, vermi-composting and vermi-wash

13 Lectures

Vermiculture: Biology of *Eisenia foetida*. culture technique earthworms. Vermicomposting technology. Vermicompost and uses, Vermiwash: Preparation, collection, composition and use.

Practical

1. Morphological characterization of common fish species.
2. Identification of two major carps – *Labeo rohita* and *Catla catla* and their life cycles.
3. Mounting of the sting apparatus of honey bee.
4. Study of castes of bees (through charts/specimens)
5. Study of leg modifications in worker honey bee and whole mount preparation of the three legs.
6. Life cycle of mulberry silkworm, *Bombyx mori* (model/chart/specimens).
7. External morphology and nomenclature of dairy animals (cow and buffalo).
8. Determination of the specific gravity of milk by using a mercury lactometer.
9. Test for good quality eggs (Floating test, cracking test) and for fertilized and unfertilized eggs (Light test, Cracking test).
9. External morphology and races of poultry birds (Photographs, model).
10. Project report on visit to dairy farm (dairy breeds and management) and visit to Poultry farm (Poultry breeds and management).

Suggested readings

1. Ghorai, N. (1995) Lac culture in India. Daya Publishing house.
2. Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.
3. Mani, M.S. (2006). Insects, NBT, India.
4. Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
5. Bhat, M.A. et al. (2020). A Textbook on Introduction to Sericulture and Soil. **Innovative**, Publication Pvt. Ltd.

Minor Course: ZOUAMNT1 and ZOUAMNL1

Semester	Minor Course	Course Title	Credits
I	1	Animal Diversity of Non chordates (Protista to Pseudocoelomate)	Theory: 03 Practical: 01

About the course

The course is a walk for the Bachelor's entrant through the amazing diversity of living forms from simple to complex one. It enlightens how each group of organisms arose and how did they establish themselves in the environment with their special characteristics. It also deals with the differences and similarities between organisms on the basis of their morphology and anatomy which led to their grouping into taxa and clades.

Course outcomes

After successfully completing this course, the students will be able to:

1. Develop understanding on the diversity of life with regard to protists to pseudocoelomata.
2. Group animals on the basis of their morphological characteristics/ structures.
3. Develop critical understanding how animals changed from a primitive cell to a collection of simple cells to form a complex body plan.
4. Examine the diversity and evolutionary history of a taxon through the construction of a basic phylogenetic/ cladistics tree.
5. Understand how morphological change due to change in environment helps drive evolution over a long period of time.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Protista, Parazoa and Metazoa

14 Lectures

General characteristics and classification up to classes; Study of *Euglena*, *Amoeba* and *Paramecium*; Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*; Locomotion and Reproduction in Protista; Types of symmetry.

Unit 2: Porifera

08 Lectures

General characteristics and classification up to classes; Type study of *Sycon*; Canal system and spicules in sponges.

Unit 3: Cnidaria

10 Lectures

General characteristics and classification up to classes; Type study of *Obelia*; Polymorphism in Cnidaria; Corals and coral reefs.

Unit 4: Platyhelminthes

10 Lectures

General characteristics and classification up to classes; Type study, larval forms and pathogenicity of *Fasciola hepatica*.

Unit 5: Nematelminthes

8 Lectures

General characteristics and classification up to classes; Type study of *Ascaris lumbricoides*; Life cycle and pathogenicity of *Wuchereria bancrofti*; Parasitic adaptations in helminthes.

Practical

1. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*
2. Binary fission and Conjugation in *Paramecium*
3. Examination of pond water collected from different places for diversity in Protista
4. Study of Sycon (T.S. and L.S.), *Hyalonema*, *Euplectella*, *Spongilla*
5. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Meandrina*, *Madrepora*
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (slides/micro-photographs)
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

Minor Courses: ZOUBMNT1 and ZOUBMNL1

Semester	Minor Course	Course Title	Credits
II	2	Animal Diversity of Non chordates (Coelomates)	Theory: 03 Practical: 01

About the course

To discuss representative lineages of the protostome coelomates, including molluscs, annelids and arthropods. Students will know how are these groups of animals similar? What morphological and developmental patterns do they have in common? How do they differ?

They will know the importance of segmentation in the annelids. Students will come to know why the animals in Phylum Arthropods are thought to be so successful.

Course Outcomes

1. Compare the two groups (Acoelomate and Coelomates) of animals with true coeloms.
2. Compare the differences in development seen in these two groups.
3. Compare the protostomes and deuterostomes
4. Explain the characteristics of arthropods that have made them successful.
5. Review the diversity of arthropod groups, including trends in arthropod evolution.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Coelomates and Annelida

12 Lecture

Evolution of coelom and metamerism. General characteristics and Classification up to classes; Type study of *Pheretima*; Metamerism in Annelids.

Unit 2: Arthropoda

15 Lecture

General characteristics and Classification up to classes; Type study of *Periplaneta*; Vision and Respiration in Arthropoda; Larval forms in Arthropoda; Metamorphosis in Insects; Social life in bees.

Unit 3: Onychophora

03 Lecture

General characteristics and Evolutionary significance with special reference to *Peripatus*.

Unit 4: Mollusca

12 Lecture

General characteristics and Classification up to classes; Type study of *Pila*; Respiration in Mollusca; Torsion and detorsion in Gastropoda; Pearl formation in bivalves; Evolutionary significance of trochophore larva.

Unit 5: Echinodermata

10 Lecture

General characteristics and Classification up to classes; Type study of *Asterias*; Water-vascular system in Asteroidea; Larval forms in Echinodermata; Affinities with Chordates.

Practical

1. Study of following specimens:
Annelids: *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Serpula*, *Chaetopterus*, *Pheretima*, *Hirudinaria* etc.
Arthropods: *Limulus*, *Palamnaeus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta*, termites and honey bees etc.
Onychophora: *Peripatus*
Molluscs: *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Pinctada*, *Sepia*, *Octopus*, *Nautilus* etc.
Echinodermates: *Pentaceros/Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Cucumaria* and *Antedon* etc.
2. Study of digestive system of earthworm
3. Study of septal nephridia and pharyngeal nephridia of earthworm
4. T. S. through pharynx, gizzard, and typhlosolar intestine of earthworm
5. Mount of mouth parts and dissection of digestive system of *Periplaneta*
6. Dissection of nervous system of *Periplaneta*
7. To submit a project report on any related topic to larval forms (crustacean, mollusc and echinoderm)

Suggested readings

1. Ruppert and Barnes (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Barnes RSK, Calow P, Olive PJW, Golding DW and Spicer JI (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science.
3. Barrington EJW (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
4. Nigam (1997). Biology of Chordates, S. Chand.
5. Kotpal, Modern text book of Zoology: Vertebrates, Rastogi Publication.

Minor Courses: ZOUCMNT1 and ZOUCMNL1

Semester	Minor Course	Course Title	Credits
III	3	Diversity of Chordates	Theory: 03 Practical: 01

About the course

By the study of diversity of chordates, it would be easy to know about the species of chordates surviving in different ecological areas of world. It would also be very useful that how these species may be harmful or useful for mankind.

Course outcomes

1. To get information about the diversity of chordates
2. To have awareness about the beneficial and harmful chordates
3. To know about the endangered species of chordates
4. To know about the management of chordates
5. To understand how environment helps to acquire adaptation over a long period of time in different animals.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction and origin of Chordates

05 Lectures

General characteristics and outline classification, Dipleurula concept and the Echinoderm theory of origin of chordates, Advanced features of vertebrates over protochordates.

Unit 2: Protochordata

08 Lectures

General characteristics of Hemichordata, Urochordata and Cephalochordata, Study of larval forms in Protochordates, Retrogressive metamorphosis in Urochordata.

Unit 3: Agnatha and Pisces

10 Lectures

General characteristics and classification of cyclostomes up to orders; General characteristics of Chondrichthyes and Osteichthyes and Classification up to orders, Skin and Scales, Migration, Osmoregulation and Parental care in fishes.

Unit 4: Amphibia and Reptilia

13 Lectures

Origin of *Tetrapoda* (Evolution of terrestrial ectotherms), General characteristics and classification of Amphibia up to orders, Parental care in Amphibians; General characteristics and classification of Reptilia up to orders, Affinities of *Sphenodon*, Poisonous and non-poisonous snakes, Poison apparatus and biting mechanism.

Unit 5: Aves and Mammalia

16 Lectures

General characteristics and classification of Aves up to orders, *Archaeopteryx*- a connecting link; Principles and aerodynamics of flight, Flight adaptations, Migration in birds; General characters and classification of Mammalia up to orders, Affinities of Prototheria, Metatheria, Adaptive radiation in mammals: locomotory appendages.

Practical

1. Study of following specimens:
Protochordata: *Balanoglossus*, *Herdmania*, *Branchiostoma*, Colonial Urochordata; Agnatha and Fishes: *Petromyzon*, *Myxine*, *Scoliodon*, *Sphyrna*, *Pristis*, *Torpedo*, *Chimaera*, *Mystus*, *Heteropneustes*, *Labeo*, *Catla*, *Cirrhinus*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Tetrodon*, *Diodon*, *Anabas*, *Flat fish*. Amphibia and Reptilia: *Ichthyophis*, *Necturus*, *Rana*, *Bufo*, *Hyla*, *Alytes*, *Salamandra*, *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Ophiosaurus*, *Draco*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis*, *Crocodylus*, *Key for Identification of poisonous and non-poisonous snakes*. Aves and Mammalia: Study of common birds from different orders, Types of beaks and claws, *Sorex*, *Bat* (Insectivorous and Frugivorous), *Rattus*, *Funambulus*, *Loris*, *Herpestes*, *Erinaceus*.
2. Sections of *Balanoglossus* through proboscis and branchiogenital regions.
3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide of *Herdmania* spicules
5. Internal ear of *Scoliodon*
6. Mount of weberian ossicles of *Mystus*/ pecten from Fowl head/Power point.
7. Study of afferent and efferent arteries of fish (*Scoliodon*).

Suggested readings

1. Young JZ (2004). The Life of Vertebrates. III Edition. Oxford university press.
2. Darlington PJ. The Geographical Distribution of Animals, R.E. Krieger Pub Co.
3. Hall BK and Hallgrímsson B (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
4. Dorit, Walker and Barnes (1991). Zoology. Brooks Cole; 1 Edition.
5. Nigam (1997). Biology of Chordates, S. Chand.
6. Kotpal : Modern text book of Zoology: Vertebrates, Rastogi Publication.

Minor Courses: ZOUDMNT1 and ZOUDMNL1

Semester	Minor Course	Course Title	Credits
IV	4	Microbiology and Parasitology	Theory: 03 Practical: 01

About the course

This is a composite course with remarkable utility and importance. Microbiology being the study of microorganisms such as viruses, bacteria etc., covers theoretical studies and practical proficiency training which may help in their placement at a clinical microbiological laboratory. Parasitology component takes care of the parasites and parasitism, emphasizing the influence of parasites on the ecology and evolution of free living species, and the role of parasites in global, public, health.

Course outcomes

After successfully completing this course, the students will be able to:

- Carry out common procedures for culturing, purifying and diagnostics of micro-organisms understand the disease-causing potential of bacteria and viruses, and the responses of the immune system.
- Describe the mechanism for transmittance, virulence, and pathogenecity in pathogenic micro-organisms.
- Diagnose the causative agents, describe pathogenesis and treatment for diseases like malaria, leishmaniasis, trypanosomiasis, toxoplasmosis, schistosomiasis, cysticercosis, filariasis etc.
- Understand the variation amongst parasites, parasitic invasion in both plants and animals;applicable to medical and agriculture aspects.
- Help to know the stages of the life cycles of the parasites and the respective infective stages.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	2	3	3	1	1
CO2	3	3	1	-	1	1	3	1	1
CO3	3	2	3	-	1	1	3	1	-
CO4	3	2	1	-	-	-	2	-	-
CO5	3	2	1	-	-	-	2	-	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Microbiology: A brief account of pathogenic bacteria.

13 Lectures

Brief history of microbiology- germ theory of disease, discovery of penicillin. Diversity of microbes- viruses and bacteria. Host pathogen interaction: invasion, antigenic heterogeneity, toxins and enzymes secretions. Kinetics of bacterial growth and staining techniques.

Unit 2: Microbiology: A brief account of pathogenic viruses

13 Lectures

Viral diseases: polio, rabies, hepatitis, influenza, dengue, AIDS, chicken pox, swine flu with emphasis on their causative agents, pathogenesis, diagnosis, prophylaxis. Bacterial diseases caused by *Streptococcus pneumoniae*, *Salmonella typhi*, *Escherichia coli*, *Helicobacter pylori*, *Mycobacterium tuberculosis*, *Vibrio cholerae*. Fungal diseases: Ringworm infection, aspergillosis, candidiasis.

Unit 3: Introduction to Parasitology

13 Lectures

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) Host parasite relationship, Population dynamics of parasite and establishment of parasite population in host body, evolution of parasitism, evolution and coevolution of parasite with respect to host strategy.

Unit 4: Parasitic Protists and Platyhelminthes

12 Lectures

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Plasmodium vivax*, *Fasciolopsis buski*, *Schistosoma haematobium*, *Taenia solium*.

Unit 5: Parasitic Nematodes and Arthropoda

12 Lectures

Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis*. Biology, importance and control of ticks, mites, *Pediculus humanus* (Head and Body louse), *Xenopsylla cheopis* and *Cimex lectularius*.

Practical

Practical

1. Study of permanent slides and specimens of parasitic protozoans and helminthes.
2. Pathological examination of sputum, blood, urine and stool.
3. Blood: Erythrocyte Sedimentation Rate (ESR), Haematocrit.
4. Staining and identification of Gram positive and Gram negative bacteria.
5. Preparation of thin and thick blood films to diagnose Plasmodium infections.
6. Preparation of temporary and permanent slides of faecal matter by saline preparation and concentration techniques to identify cysts of parasitic protozoans and helminthes eggs.
7. Group discussion or Seminar presentation on one or two related topics to those provided in the list.
8. Study of life stages of *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* and *Plasmodium vivax* through permanent slides/micro photographs.
9. Study of adult and life stages of *Fasciolopsis buski*, *Schistosoma haematobium* and *Taenia solium* through permanent slides/microphotographs.
10. Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale*, *Wuchereria bancrofti* and *Trichinella spiralis* through permanent slides/microphotographs.
11. Study of *Pediculus humanus* (Head louse and Body louse), *Xenopsylla cheopis* and *Cimex lectularius* through permanent slides/ photographs.
12. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as by product]

Recommended readings

1. Jawetz, M. and Adelberg (2015) Medical Microbiology (27th edition)
2. Chatterjee, K.D (2015) Parasitology (13th edition)
3. Goldsby, R.A.; Kindt, T.J. and Kuby, J. (2006) Immunology (6th edition).
4. Roitt, I.; Brostoff, J. and Male, D. (2012) Immunology (8th edition).
5. Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors
6. Noble, E.R. and Noble, G.A. (1982) Parasitology: The Biology of Animal Parasites. V Edition, Lea &Febige

Minor Courses: ZOUEMNT1 and ZOEMNL1

Semester	Minor Course	Course Title	Credits
V	5	Physiology of Basic Life Processes	Theory: 03 Practical: 01

Course Objective:

To acquaint students with the principles and basic facts of animal physiology in relation with integumentary system, digestion, respiration, renal physiology, blood and physiology of heart to promote student understanding.

Course Outcomes:

To Understand fundamental principles of animal physiology and life sustaining systems.

To understand the processes involved in formation and functioning of integumentary system.

To understand the mechanism of respiration and circulatory physiology in animals.

To understand the processes involved in functioning of digestion and renal physiology in animals.

To gain experience in discussing and answering questions about animal physiology

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	1	1
CO5	3	3	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Integumentary system

8 Lectures

Cell junction, epithelial and connective tissue, structure, type and function of skin, accessory structure of skin.

Unit 2: Digestion

12 Lectures

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in gastrointestinal tract.

Unit 3: Respiration

10 Lectures

Mechanism of breathing and respiration: Pulmonary ventilation; Transport of oxygen and carbon dioxide in blood; Respiratory volumes and capacities; Respiratory pigments, Control of respiration

Unit 4: Excretion

10 Lectures

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

Unit 5: Blood and circulation

10 Lectures

Components of blood and their functions; Structure and functions of hemoglobin Hemostasis: Blood clotting system, Hemopoiesis Blood groups: Rh factor, ABO and MN
Structure of mammalian heart; Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate.

Practical

10. To study structure of skin with the help of chart/model.
11. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, liver and pancreas through permanent slides.
12. Determination of ABO Blood group.
13. Enumeration of red blood cells and white blood cells using haemocytometer.
14. Estimation of haemoglobin using Sahli's haemoglobinometer.
15. Preparation of haemin and haemochromogen crystals.
16. Recording of frog's heart beat under *in situ* and perfused conditions*.
17. Recording of blood pressure using a sphygmomanometer.
18. Examination of sections of mammalian lung and kidney through permanent slides.

Suggested readings

5. Guyton AC and Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Harcourt Asia PTE Ltd. W.B. Saunders Company.
6. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
7. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
8. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

Minor Courses: ZOUFMNT1 and ZOUFMNL1

Semester	Minor Course	Course Title	Credits
VI	6	Physiology of Regulatory Life Processes	Theory: 03 Practical: 01

About the course

To familiarize students with the principles and basic facts of animal physiology. Emphasis will be placed on control and coordination of tissues, bone and cartilage, muscle and nervous system.

Course outcomes

6. To understand fundamental principles of animal physiology.
7. To understand how these principles are incorporated into to regulate life process.
8. To understand control and coordination of various organ systems in animals i.e. tissues, bone and cartilage, muscle.
9. To understand the working and importance of nervous system in animals.
10. To gain experience in discussing, and answering questions about animal physiology.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1
CO5	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit1: Tissues

10 Lectures

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue.

Unit 2: Bone and cartilage

12 Lectures

Structure and types of bones and cartilages, Ossification, bone growth.

Axial skeletal: skull and vertebral column, appendicular skeletal: pectoral and pelvic girdle, limbs, joints.

Unit3: Muscle

08 Lectures

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus.

Unit 4: Nervous system

10 Lectures

Type of nervous tissue: neuron and glia; Structure of brain, cerebrospinal fluid, neural network, cranial nerves, blood brain barrier, spinal cord anatomy, spinal nerves.

Unit 5: Electrical signal in neurons

10 Lectures

Axonal and synaptic transmission: Membrane potential and action potential; Types of synapses and synaptic knobs; Excitatory and inhibitory post-synaptic potential; Chemical transmission; Neurotransmitters (acetylcholine, catecholamines, serotonin and GABA), neuropeptides.

Practical

11. Recording of simple muscle twitch with electrical stimulation (orVirtual)
12. Study of tissues of various kind with model, chart/PPT.
13. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerkreflex)
14. Study of Axial skeletal: skull
15. Study of Axial skeletal: Vertebral column
16. Study of appendicular skeletal: Pectoral and pelvic girdle
17. Study of appendicular skeletal: Limbs.
18. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
19. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell.
20. Microtomy: Preparation of permanent slide of mammalian tissues

Suggested readings

4. Guyton AC and Hall JE (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. SaundersCompany.
5. Tortora GJ and Grabowski S (2006). Principles of Anatomy & Physiology. XI Edition John Wiley &sons
6. Victor P Eroschenko (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. &Wilkins.

Minor Courses: ZOUGMNT1 and ZOUGMNL1

Semester	Minor Course	Course Title	Credits
VII	7	Immunology	Theory: 03 Practical: 01

Course Outcome

- To provide knowledge on essential features of antigens and antibodies and their types.
- To acquire knowledge on types of immunity, phagocytosis, interferons and complement system.
- To explain the concept of different types of hypersensitivity, and transplantation.
- To provide knowledge on immune deficiencies and several immunological techniques.

Learning Outcomes

1. Gain knowledge on essential features of different types of antigens, antibodies.
2. Out line, compare and contrast the key mechanism of innate and adaptive immunity.
3. Gain knowledge on undesirable immunological reactions and their complications in health management and transplantation.
4. Apply knowledge in disease diagnosis through serological tests.
5. Understand the autoimmune diseases and techniques in immunology.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	3	2	1
CO2	3	3	2	2	1	1	3	2	1
CO3	3	3	1	2	1	3	3	3	2
CO4	3	2	1	2	-	2	3	2	-
CO5	3	2	-	1	-	3	3	1	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Immunology: Immune mechanism and related pathways

12 Lectures

Scope of Immunology, Historical background of Immunology, Biological aspects of Immunology, Self and non-self-recognition, specificity, memory of immune system. Cells and organs of immune system- primary and secondary lymphoid organs. Innate immunity: First and second lines of defense.

Unit 2: Antigen-antibody Interaction

13 Lectures

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, alternative and lectin pathways).

Unit 3: Acquired immunity

13 Lectures

Acquired immunity: 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 function. MHC complex and molecules with classification and function.

Unit 4: Hypersensitivity and Disorders of Immune System

13 Lectures

Types, clinical diseases. Blood groups: AB, Rh system, Lewis-Luthern systems, significance, Erythroblastosis foetalis. Auto immunity: Introduction, Auto recognition, classes of auto immuno diseases. Transplantation: Terminology, Auto graft, Isograft, Allograft, Xenograft, Immunological basis of transplantation reactions, GVH reaction, Immuno suppression, General mechanisms of Immune suppression, Immune suppression, drugs (azothioprine, methotrexate, cyclophosphamide, cycosporin-A, Steroids).

Unit 5: Immunological techniques

12 Lectures

Hybridoma technology, monoclonal antibodies, immunotoxins. Radioimmunoassay: ELISA – Principle, Methodology and applications. Immuno-fluorescence: Direct, indirect and Sandwich, *in situ* localization by techniques such as FISH and GISH.

Practical

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/photographs.
3. Preparation of stained blood film to study various types of blood cells.
4. ABO Blood group antigen determination by heamagglutination.
6. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of:
 - (a) ELISA
 - (b) Immunoelectrophoresis
8. Detection of complement activity using haemolysis of antibody coated SRBC and standard Serum.
9. Demonstration of antigen-antibody interaction in gel.
10. Separation of γ -globulin by salt precipitation.
11. Group discussion or Seminar presentation on one or two related topics to those provided in the list.

Recommended Books:

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J. (2006). Immunology, VI Edition, W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan, R. (2006). Immunology, VII Edition, Mosby, Elsevier Publication.
3. Essential immunology- Ivan M. Roitt.
4. Introduction to Immunology – John W. Kinball.
5. Immunology – D. M. Weir.

Minor Courses: ZOUHMNT1 and ZOUHMNL1

Semester	Minor Course	Course Title	Credits
VIII	8	Research Methodology and Biostatistics	Theory: 03 Practical: 02

About the course

The course to introduce students to the important aspects of research and statistics in biology. The course covers all the conceptual and methodological issues that go into successful conduction of research. That includes philosophy of science, the methodological issues in measurement, proposing and testing hypotheses, scientific communication and the ethical issues in the practice of science. It also provides foundation on statistical methods to enable students to compute and interpret basic statistical parameters. By going through this course, students are likely to be able to take up research activities in a more systematic and formal manner right from the beginning.

Learning outcomes

1. Students will understand research types, processes, ethics, and develop critical analysis skills.
2. Students will comprehend research design, problem formulation, literature review, objectives, and variables.
3. Students will master research report types, structure, writing, and audience considerations.
4. Students will learn data representation, probability distributions, and statistical measures comprehensively.
5. Students will analyze correlations, regression, ANOVA, and perform hypothesis testing effectively.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	3	3	3	3	1	1
CO2	3	2	1	1	2	2	3	1	1
CO3	3	2	2	1	2	2	3	1	1
CO4	3	2	3	1	3	3	3	1	1
CO5	3	2	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Basics of Research:

12 Lectures

Meaning, objectives and motivations in research, Characteristics and limitations of research, Components of research work, Criteria of good research, Research process, Types of Research, Fundamental, Pure or Theoretical Research, Applied Research, Descriptive Research, Evaluation Research, Experimental Research, Survey Research, Qualitative Research, Quantitative Research, Historical Research. Ethical issues in research: Code of Ethics in Research, Ethics and Research Process, Importance of Ethics in Research.

Unit 2: Research Designs:

12 Lectures

Research Design, definition, essentials and types of research design, errors and types of errors in research design. Research problem: Selecting and analyzing the research problem, problem statement formulation, formulation of hypothesis. Literature review: purpose, sources, and importance, literature review procedure. Objectives: Learning Objectives; Definitions; Formulation of the research objectives. Variables in Research, Measurement and scaling, Different scales, Construction of instrument, Validity and Reliability of instrument.

Unit 3: Research Report Writing:

8 Lectures

Research report, Different types, Contents of report, executive summary, chapterization, contents of chapter, report writing, the role of audience, readability, comprehension, tone, final proof, report format, title of the report.

Unit 4: Data collection and processing for authentication and analysis **10 Lectures**

Collection and classification of data. Graphical representation of data: Pie chart, Bar diagram, Histogram, Frequency polygon. Cumulative frequency curve (Ogive), Box plot. Probability theory: Binomial distribution, Poisson distributions. Measures of central tendency: Arithmetic Mean, Median, Mode; Measures of dispersion: Variance, Standard deviation and Standard error, Concept of Coefficient of variation.

Unit 5: Correlation regression and analysis of variance etc. **10 Lectures**

Correlation: Types of correlation, Calculation of correlation in continuous data and ordinal data. Regression: Linear regression, regression coefficient. Analysis of variance (ANOVA): One way, post-hoc tests. Hypothesis testing: Parametric tests (Paired and unpaired t-test, z-test, F-test) & Non Parametric tests (Chi-square test, Mann-Whitney U-test)

Practical

21. Designing research frameworks and identifying variables.
22. Preparing and validating survey instruments (e.g., questionnaires, interviews).
23. Graphical representation of data (Pie charts, Bar diagrams, Histograms, Ogives, Box plots).
24. Demonstration of reference formatting (e.g., Endnote, Mendeley, Zotero).
25. Proofreading research paper
26. Calculation of mean, standard deviation and standard error.
27. Student's t-test: Independent and dependent. Hand calculation and calculation using MS Excel.
28. Conducting Analysis of Variance (ANOVA) and post-hoc tests.
29. Calculation of correlation coefficient values and finding out the probability
30. Calculation of 'F' value and finding out the probability value for the F value.

Recommended readings

1. Daniel, W.W. (2012) Biostatistics: A Foundation for Analysis in Health Sciences (10th edition) John Wiley.
2. Milton, J.S. & Tsokos, J.O. (1992) Statistical Methods in the Biological and Health Sciences (2nd edition) McGraw Hill.
3. Zar, J.H. (2013) Biostatistical Analysis (5th edition) Pearson.
4. Kothari, C.R., (2004). Research methodology: Methods and techniques. New Age International.
5. Coolican, H. (2004). Research methods and Statistics in Psychology. London: Hoddes Arnold
- Kerlinger, N. (1996). Foundations of behavioural research. India: Prentice Hall

Minor Courses: ZOUHMNT2 and ZOUHMNL2

Semester	Minor Course	Course Title	Credits
VIII	9	Applied Zoology	Theory: 03 Practical: 02

About the course

The course is unique in highlighting the commercial and industrial significance/value of animals. It discusses the techniques/ methods of rearing of animals for commercial usage and the prerequisites for their successful maintenance and sustenance.

Learning outcomes

9. Understanding the culture techniques of prawn, pearl and fish.
10. Understanding the silkworms rearing.
11. Understand the bee keeping, equipments used and apiary management.
12. Understand dairy animals management, the breeds and diseases of cattle and learn about the milk quality.
13. To understand about the poultry birds and their management.
14. Learn various concepts of lac cultivation.
15. To learn the vermi-composting and vermi-wash preparation and their importance in crop production.
16. Be aware of a broad array of career options and activities in human medicine, biomedical research and allied health professions.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	1	1
CO5	3	3	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Aquaculture

13

Lectures

Prawn culture: Culture of fresh water and marine prawn; Preparation of farm. Preservation and processing of prawn. Pearl Culture: Technique of pearl culture; Types and chemical composition of pearl. Fish Culture: Major carps; Ponds of fish culture. Composite fish culture. Induced breeding. Transportation of fish seeds. Preservation of fish. By products of fish. Fish diseases.

Unit 2: Apiculture, Lac culture and Sericulture

13

Lectures

Apiculture: Bee species and caste. Life history of *Apis*. Social organization of honey bee. Methods of Bee keeping. Bee products and their uses. Diseases and their control measures. Lac culture: Lac insect and its life cycle. Host plants and cultivation of lac insect. Processing of raw lac. Chemical composition and uses of lac. Sericulture: Types of silkworms, silk and their host plants; Life history of silkworm; Mulberry silkworm culture; Natural enemies and diseases and their control.

Unit 3: Dairy management

05

Lectures

Introduction to common dairy animals (cow and buffalo). Morphological characteristics of cow. Techniques of dairy management: Housing, feeding and breeding management. Transportation of milk. Cattle diseases.

Unit 4: Poultry farming

08

Lectures

Breeds of fowl. Housing and Equipments, Rearing technology: Deep litter and cage system; Management of growers, Layers, Broilers; Feed formulations for chicks, Debeaking. Egg collection and preservation. Diseases of fowl.

Unit 5: Vermi-culture, vermi-composting and vermi-wash

13

Lectures

Vermiculture: Biology of *Eisenia foetida*. culture technique earthworms. Vermicomposting technology. Vermicompost and uses, Vermiwash: Preparation, collection, composition and use.

Practical

1. Morphological characterization of common fish species.
2. Identification of two major carps – *Labeo rohita* and *Catla catla* and their life cycles.
3. Mounting of the sting apparatus of honey bee.
4. Study of castes of bees (through charts/specimens)
5. Study of leg modifications in worker honey bee and whole mount preparation of the three legs.
6. Life cycle of mulberry silkworm, *Bombyx mori* (model/chart/specimens).
7. External morphology and nomenclature of dairy animals (cow and buffalo).
8. Determination of the specific gravity of milk by using a mercury lactometer.
9. Test for good quality eggs (Floating test, cracking test) and for fertilized and unfertilized eggs (Light test, Cracking test).
9. External morphology and races of poultry birds (Photographs, model).
10. Project report on visit to dairy farm (dairy breeds and management) and visit to Poultry farm (Poultry breeds and management).

Suggested readings

1. Ghorai, N. (1995) Lac culture in India. Daya Publishing house.
2. Jabde, P.V. (2005) Text Book of Applied Zoology: Vermiculture, Apiculture, Sericulture, Lac culture.
3. Mani, M.S. (2006). Insects, NBT, India.
4. Shukla, G.S. and Upadhyaya, V.B. (1999-2000). Economic Zoology (Rastogi Publishers).
5. Bhat, M.A. et al. (2020). A Textbook on Introduction to Sericulture and Soil. **Innovative**, Publication Pvt. Ltd.

Multidisciplinary Course: ZOUAMDT1

Semester	Multidisciplinary Course	Course Title	Credits
I	MDC-1	Introductory Zoology	Theory: 03

About the course

The course provides a detailed insight into basic concepts of biomolecules and their importance; cellular structure and function. It also gives an account of genetics and evolutionary mechanism.

Course Outcomes

1. Understand the functioning of nucleus and extra nuclear organelles and understand the intricate cellular mechanisms involved.
2. Understand about the importance and scope of biomolecules. Understand the structure and biological significance of carbohydrates, proteins, lipids and nucleic acids.
3. Understand how DNA encodes genetic information and the function of mRNA and tRNA. Apply the principles of Mendelian inheritance.
4. Understand how developmental processes and gene functions within a particular tissue or organism can provide insight into functions during evolution.

Course Outcomes and their mapping with Programme Outcomes:

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	2	2	3	1	1
CO2	3	3	3	1	2	2	3	1	1
CO3	3	3	3	1	2	2	3	1	1
CO4	3	3	3	1	2	2	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Biomolecules

10 Lectures

Chemical foundation of life. Principle of biomolecular organization, configuration and conformation. Water as biological solvent. Structure and biological importance of carbohydrates, lipids, proteins and nucleic acids.

Unit 2: Cell

10 Lectures

General structure of prokaryotes, bacteria, archaea and eukaryotes. Cell theory. Structure and functions of endoplasmic reticulum, ribosome, Golgi apparatus, lysosome, peroxisomes, mitochondria, cytoskeleton, and nucleus. Cell cycle, cell division- mitosis and meiosis.

Unit 3: Genetics

10 Lectures

Mendel's laws of inheritance; Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Multiple allelism ; Concept of Gene; Elementary idea of gene expression and regulation; Mutation; 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).

Unit 4: Evolutionary biology

10 Lectures

Origin of life on earth, Miller-Urey Experiment; Oparin-Haldane theory; Sources and types of variations; Theories of evolution: Lamarckism; Darwinism; Mutation theory, Modern synthetic theory; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive); Isolating mechanisms and modes of speciation.

Recommended readings

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments (6th edition) John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.
3. Nelson, D.L. & Cox, M.M. (2017) Lehninger Principles of Biochemistry (7th edition) Worth.
4. Berg, J.M.; Tymoczko, J.L. and Stryer, L. (2012) Biochemistry (7th edition) Freeman.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. (VIII edition) Wiley India.
6. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. (V edition) John Wiley and Sons Inc.
7. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2012). Concepts of Genetics. (X edition) Benjamin Cummings.
8. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007) Evolution. Cold Spring, Harbour Laboratory Press.
9. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett

Multidisciplinary Course: ZOUDMDT1

Semester	Multidisciplinary Course	Course Title	Credits
II	MDC-II	Essentials of Zoology	Theory: 03

About the course

The course provides an insight into elementary biology for non biology background learners.

Course outcomes

After successfully completing this course, the students will be able to:

1. Able to identify and differentiate different types of tissue.
2. Understand the structure and function of respiratory and circulatory systems.
3. Able to understand functioning of digestive and excretory system.
4. Understand the structure and function of reproductive system and importance of endocrine system in our daily life processes.

Course outcomes and their mapping with programme outcomes

	PO						PSO		
CO	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	-	-	2	1	3		
CO2	3	3	3	-	2	2	2		
CO3	3	3	1	-	3	1	2		
CO4	3	3	3	2	2	2	2		

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Animal tissue

10 Lectures

General introduction of tissue; Epithelial tissue: Characteristics and types; Connective tissue: connective tissue proper; vascular tissue (composition and functions of blood and bone); muscular tissue (types, characteristics and functions); nervous tissue (types and functions).

Unit 2: Respiratory and circulatory system

10 Lectures

Structural organization and functions of respiratory system; general concept of breathing and respiration; Respiratory pigment: Structure and functions of hemoglobin.

Structure and functions of mammalian heart; Circulation; Origin and conduction of cardiac impulses; Cardiac cycle; Blood clotting; Blood groups.

Unit 3: Digestive and excretory system

10 Lectures

Structural organization and functions of gastrointestinal tract and associated glands; Digestion and absorption of food (carbohydrates, lipids, proteins and vitamins); Balance diet.

Structure of kidney and its functional unit; general mechanism of urine formation; Kidney function test.

Unit 4: Reproductive system and endocrinology

10 Lectures

Modes of reproduction- asexual and sexual reproduction; Male and female reproductive organs, Accessory sex organs; Reproductive cycles; Gametogenesis; Fertilization. Definition and Classes of hormones; General structure and function of endocrine glands; Brief idea about regulation of hormone action.

Recommended readings

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

Skill Enhancement Course (SEC): ZOUASET1 and ZOUASEL1

Semester	SEC	Course Title	Credits
I	SEC-1	Aquaculture	Theory: 02 Practical: 01

About the course

This course will give the students an understanding of the principles of aquaculture, including production systems, water quality, nutrition, spawning, larval culture and culture methodologies with special reference to fish, and prawn. The course will include an opportunity to conduct hands-on activities related to culture and husbandry of animals

Course outcomes

After completing this course the learners will be able to

1. Understand the aquaculture systems
2. Understand pond management to increase fish production
3. Understand fish breeding and health management
4. Understand the environmental impacts on aquaculture

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	1	2	-	-	1
CO2	3	1	3	1	1	2	1	1	2
CO3	3	3	2	2	2	3	1	1	2
CO4	3	1	3	1	2	3	-	1	2

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Freshwater aquaculture systems

08 Lecture

Aquaculture concept, Culture systems: Freshwater prawn culture, fish culture in paddy fields, Culture of Catfishes. Composite fish culture: Techniques of composite culture. Composite fish farming in India. Mariculture: Brackish water prawn culture. Mussel culture. Culture of aquatic weeds.

Unit 2: Preparation and management of fish culture ponds

08 Lecture

Fish culture ponds. Pond management: Fish toxicants. Predatory and Weed fishes and their control. Aquatic insects and their control. Fish manures. Water quality. Culture: Pond culture. Monoculture. Monosex culture. Supplementary feeding. Harvesting: Fishing techniques, preservation & processing of fish.

Unit 3: Fish breeding, Transportation and Pathology

09 Lecture

Fish breeding: Natural and artificial. Fish transportation: Methods for packaging and transport of fish. Transport of fish seed and Brood fish. Causes of mortality in transport. Use of chemicals in live fish transport: Anesthetic drugs. Antiseptics and Antibiotics. Fish diseases: Bacterial, fungal, protozoan and helminthes diseases. Non parasitic diseases.

Unit 4: Technologies in Fisheries development

10 Lecture

Pearl culture: Introduction, Pearl producing mollusks, pearl formation, collection of oysters, Rearing of oysters, insertion of nucleus, harvesting of pearls, composition & quality of pearl. Recirculation technology. Geographic Information System (GIS) technology. Passive Acoustics in fisheries, Use of Information Communication Technology (ICT) in fishes: production aspects, marketing aspects.

Practical

1. Estimation of dissolved oxygen
2. Determination of pH of water samples
3. Measuring turbidity using a secchi disk
4. Measuring salinity of water
5. Total alkalinity measurement in natural waters
6. Phytoplankton analysis
7. Measurement of productivity
8. Study of major carps
9. Study of prawn species
10. Study of pearl oysters

Suggested readings

1. Jingran, V. G. (1983) Fish and fisheries of India, Hindustan pub. corp. New Delhi.
2. Hute, M. and Kahn, H. (2000) Textbook of fish culture, Blackwell Scientific Publication, Australia.
3. Srinivasulu, M., Reddy, K.R.S., Rao, S. (1999) Text book of Aquaculture, Discovery Publishing House New Delhi.
4. Yawn Mehta, Fisheries & Aquaculture Biotechnology (2011) Campus Books International, Prahalad street, Ansari Road, Durga Ganj, New Delhi.

Skill Enhancement Course (SEC): ZOUBSET1 and ZOUBSEL1

Semester	SEC	Course Title	Credits
II	SEC-2	Apiculture	Theory: 02 Practical: 01

About the course

This course tells the students what tools and equipment will be needed, the main activities in the beekeepers year, the laws and by laws governing keeping bees; discover the principles of sustainable beekeeping and how these principles can guide your beekeeping into an enduring practice.

Course outcomes

Upon successful completion of this course, the student should be able to:

1. Understand about bees and colony organization
2. Understand about beekeeping as a highly profitable occupation
3. Understand bee keeping technology and bee products
4. Understand about National Institutes and their contribution in beekeeping

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Introduction to Apiculture

08 Lectures

History of Bees and Beekeeping. Bee species: Types of Bees. Morphology Caste system. Colony organization. Bee flora, Foraging.

Unit 2: Bee keeping as an occupation

08 Lectures

Extent of Beekeeping India. Limitations on the development of beekeeping, Advantages of extensive Beekeeping. Beekeeping equipments: Rearing appliances and initiation into keeping a colony. The future of beekeeping.

Unit 3: The first step in beekeeping

10 Lectures

Apiary site. Purchase and Establishment of a bee colony. Management and manipulation of bee colony. Bee products: Honey, Bees wax, Pollens, Royal Jelly, Propolis and Bee venom. Taking care of bee diseases and enemies.

Unit 4: Beekeeping techniques and Apiary management

09 Lectures

Routine and Seasonal management, Migratory beekeeping, Harvesting and marketing of bee products. Important Institutions pertinent to Apiculture: National Bee Board, Bee research and Training Institute, Apiaries. Economics and extension of Bee keeping.

Practical

1. Study of different species of honey bee
2. Study of various host flowers of honey bee
3. Study of various caste of honey bee
4. Study of life cycle of honey bee
5. Study of Movable hive (Newton's hive) for apiculture
6. Study of various appliances used in apiculture
7. Study of foraging legs of honey bee
8. Preparation of temporary mount of mouth parts of honey bee
9. Preparation of temporary mount of sting apparatus of honey bee
10. Study of various diseases of honey bee affecting apiculture

Suggested readings

1. Abrol , D. P. (1997) Bees and Beekeeping. Kalyani Publisher, New Delhi.
2. Abrol, D. P. (2010) A Comprehensive guide to Bees and Beekeeping. Scientific Publisher, New Delhi.
3. Withhead, S. B. (2010) Honey bees and their management Axis books Publisher, Jodhpur.
4. Nagaraja, N. and Rajagopal , D. (2013) Honey bees: Diseases, Parasites, Pests, Predator and their management. M.J.P Publisher, Chennai.
5. Dharamsing and Singh, D. P. A Handbook of Beekeeping, Agrobios India (Publisher), Jodhpur.

Skill Enhancement Course (SEC): ZOUCSET1 and ZOUCSEL1

Semester	SEC	Course Title	Credits
III	SEC-3	Sericulture	Theory: 02 Practical: 01

About the course

The course gives insight into the principles of sustainable sericulture and how these principles can guide your silkworm rearing into an enduring practice. The students will know about the laws and by laws governing keeping silkworm.

Course Outcomes

1. To know about importance of sericulture in the rural development and various species of silk moth.
2. To know biology of silkworms and technologies used in sericulture.
3. To know about the pests and diseases of silkworms and their control.
4. To know about the Institutions promoting sericulture in rural areas.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3		1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Silkworm distribution and races

08 Lecture

The silkworms: Definition, history and present status of sericulture. World silk production and silk road. Distribution and types of races. Morphological characteristics. Mulberry and non-mulberry sericulture. Sericultural practices in tropical and temperate climate.

Unit 2: Biology of silkworm and technologies used in sericulture

08 Lecture

Biology of silkworm: Life cycle of *Bombyx mori*. Structure of silk gland and Secretion of silk. Selection of mulberry variety. Propagation and establishment of mulberry garden, Rearing house and rearing appliances. Silkworm rearing technology: Early age and Late age rearing. Mounting. Spinning. Quality and storage of cocoons. Stifling. Reeling.

Unit 3: Diseases of silk worm and prevention and control

09 Lecture

Diseases and Enemies of silkworm: Uzi fly, dermestid beetles and vertebrates. Protozoan, viral, fungal and bacterial diseases. Control and prevention of pests and diseases. Disinfectants: Formalin, bleaching powder RKO.

Unit 4: Prospects of Sericulture in India

10 Lecture

Prospects of Sericulture in India. Silk industry in different states. Employment generation in sericulture. Role of women in sericulture. Sericulture organization in India; Role of state departments of Sericulture, Central Silk Board, Universities and NGOs in Sericulture development.

Practical

1. Study of various species of silkmoths
2. Study of different host plants of silkmoths
3. Identification of male and female silk moths and pupae
4. Study of life cycle of mulberry silkmoth
5. Study of 5th instar larva of silk moth
6. Study of rearing appliances used in sericulture
7. Dissection of Alimentary canal of silkmoth
8. Dissection of Silk gland
9. Preparation of temporary mount of mouthparts of silkmoth
10. Study of various diseases of silkmoths affecting sericulture

Suggested readings

1. Manual on sericulture (1976). Rome: Food and Agriculture Organization of the United Nations, Agricultural Services Division.
2. Ullal, S.R. and .Narasimhanna, M.N. (1987) Handbook of Practical Sericulture: CSB, Bangalore
3. Silkworm Rearing and Disease of Silkworm (1956) Ptd. By Director of Ptg., Stn.& Pub. Govt. Press, angalore
4. Jolly, M. S. (1986) Appropriate Sericultural Techniques; Ed., Director, CSR & TI, Mysore.
5. Handbook of Silkworm Rearing: Agriculture and Technical Manual-1 (1972) Fuzi Pub. Co. Ltd., Tokyo, Japan.
6. Narasimhanna, M. N. (1988) Manual of Silkworm Egg Production;, CSB, Bangalore.
7. Sengupta, K. (1989) A Guide for Bivoltine Sericulture. CSR & TI, Mysore.

Value Added Courses: ZOUAVAT1

Semester	VAC	Course Title	Credits
I	VAC-1	Bhartiya Vigyan Ka Itihas	Theory: 02

About the course

The course provides an insight into the status of science in ancient India, its gradual development, innovations and the pioneers in the field of science, reputed research institutions in India and cutting edge research in science.

Course outcomes

1. The students will feel pride to know the pioneer role of Indians in the development of astronomy, mathematics, engineering and medicine in the World history.
2. Develop understanding of various branches of science during different eras and analyze the role played by different Indian organizations in science.
3. Appraise the contribution of different Indian Scientists.
4. Students will be aware about the modern development of animals, agriculture and biological sciences in republic India.

Course Outcomes and their mapping with Programme Outcomes

CO	PO						PSO		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	3	2	3	3	2	1	3	2
CO2	3	3	2	3	2	2	2	3	3
CO3	3	2	2	2	2	1	2	3	2
CO4	3	2	1	2	1	2	2	2	1
CO5	-	-	-	-	-	-	-	-	-

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit I: Science in ancient and medieval India

10 Lecture

History of development in astronomy, mathematics, engineering and medicine subjects in Ancient India, Influence of the Islamic world and Europe on developments in the fields of mathematics, chemistry, astronomy and medicine.

Unit 2: Prominent Indian scientists

12 Lecture

Eminent scholars in mathematics and astronomy: Baudhayana, Aryabhatta, Brahmgupta, Bhaskaracharya, Varahamihira, and Nagarjuna, Medical science of Ancient India (Ayurveda and Yoga): Susruta, Charak. Scientists of Modern India: Srinivas Ramanujan, C.V. Raman, Jagdish Chandra Bose, Homi Jehangir Bhabha, Vikram Sarabhai etc.

Unit III: Indian science in before and after Independence

13 Lecture

Introduction of different surveyors, zoologists and doctors as early scientist in Colonial India, Indian perception and adoption for new scientific knowledge in Modern India, Establishment of premier research organizations like CSIR, DRDO and ICAR and ICMR, IIT's, Establishment of Atomic Energy Commission, Launching of the space satellites, ISRO's accomplishments. Zoological survey of India.

Recommended readings

1. Kuppuram, G. (1990) History of Science and Technology in India, South Asia Books.
2. Handa, O.C. (2014) Reflections on the history of Indian Science and Technology, Pentagon Press.
3. Basu, A. (2006) Chemical Science in Colonial India: The Science in Social History, K.P. Bagchi & Co.
4. Habib, I. (2016) A people's history of India 20: Technology in Medieval India, 5th Edition, Tulika Books.
5. Rahman, A. et al (1982) Science and Technology in Medieval India – A Bibliography of Source Materials in Sanskrit, Arabic and Persian, New Delhi: Indian National Science Academy.

6. Subbarayappa, B.V. & Sarma, K.V. (1985), Indian Astronomy — A Source Book, Bombay.
7. Srinivasan, S., Ranganathan, S. (2013) Minerals and Metals heritage of India, National Institute of Advanced Studies.
8. Srinivasiengar, C.N. (1967) The History of Ancient Indian Mathematics, World Press Private Ltd. Calcutta.
9. Bhardwaj, H.C. (2000) Metallurgy in Indian Archaeology. Tara Book Agency

Value Added Courses: ZOUBVAT1

Semester	VAC	Course Title	Credits
II	VAC-II	Food, Nutrition and Health (Health & Wellness)	Theory: 02

About the course

The course covers the basic concepts of balanced diet for people of different ages besides focusing on the consequences of malnutrition and the deficiency diseases and the diseases caused due to poor hygiene.

Course outcomes

1. Imparting the basic concept of food and nutrition including the concept of a balanced diet, nutrient needs, and dietary patterns for various groups.
2. Understanding the biochemistry of major food components and the effects of their deficiency on health and evaluating the effectiveness of nutrition interventions when dealing with certain health problems.
3. Understanding the importance of lifestyle-related diseases, their causes, and prevention through dietary and lifestyle modifications.
4. Understand the importance of food and water safety and methods associated with the preservation of food and purification of contaminated water and make students aware of food, nutrition, and health needs.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	-	3	-	3	-	1
CO2	2	3	-	1	2	-	2	2	1
CO3	1	2	1	1	2	2	2	1	-
CO4	2	1	1	2	2	1	1	2	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Nutrition and dietary nutrients

08 Lectures

Basic concept of Food: Components and nutrients. Concept of balanced diet, nutrient requirements and dietary pattern for different groups viz., adults, pregnant and nursing mothers, infants, school children, adolescents and elderly people.

Unit 2: Macro nutrients and micronutrients

09 Lectures

Nutritional Biochemistry: Macronutrients. Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role. Micronutrients. Vitamins- Water-soluble and Fat-soluble vitamins- their sources and importance. Important minerals viz., Iron, Calcium, Phosphorus, Iodine, Selenium and Zinc: their biological functions.

Unit 3: Malnutrition and nutrient deficiency diseases

10 Lectures

Definition and concept of health: Common nutritional deficiency diseases- Protein Malnutrition (e.g., Kwashiorkor and Marasmus), Vitamin A deficiency, Iron deficiency and Iodine deficiency disorders- their symptoms, treatment, prevention and government initiatives, if any. Life style dependent diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention. Social health problems- smoking, alcoholism, narcotics. Acquired Immuno Deficiency Syndrome (AIDS): causes, treatment and prevention. Other ailments viz., cold, cough, and fever, their causes and treatment.

Unit 4: Diseases caused by microorganisms

10 Lectures

Food hygiene: Potable water- sources and methods of purification at domestic level. Food and Water-borne infections: Bacterial diseases: cholera, dysentery; typhoid fever, viral diseases: Hepatitis, Poliomyelitis etc., Protozoan diseases: amoebiasis, giardiasis; Parasitic diseases: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention. Causes of food spoilage and its prevention.

Suggested readings

1. Mudambi, S.R. and Rajagopal, M.V. (2007). Fundamentals of Foods, Nutrition and Diet Therapy; Fifth Ed;; New Age International Publishers
2. Srilakshmi, B. (2002). Nutrition Science; New Age International (P) Ltd.
3. Srilakshmi, B. (2007). Food Science; Fourth Ed; New Age International (P) Ltd.
4. Swaminathan, M. (1986). Handbook of Foods and Nutrition; Fifth Ed; BAPPCO.
5. Bamji, M.S.; Rao, N.P. and Reddy, V. (2009). Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd.
6. Wardlaw, G.M. and Hampl, J.S. (2007). Perspectives in Nutrition; Seventh Ed; McGraw Hill.
7. Lakra, P. and Singh M.D. (2008). Textbook of Nutrition and Health; First Ed; Academic Excellence.
8. Manay, M.S. and Shadaksharaswamy, M. (1998). Food-Facts and Principles; New Age International (P) Ltd.
9. Gibney, M.J. et al. (2004). Public Health Nutrition; Blackwell Publishing.

Vocational Courses: ZOUBVOT1 and ZOUBVOL1

Semester	Vocational Course	Course Title	Credits
II	VOC-I	Ornamental Fish Culture	Tutorial: 01 Practical: 03

About the course

To make the students aware of the vast potentials involved in ornamental fish farming and trading besides making them learn the diseases in fishes and other constraints in their culturing.

Learning outcomes

After completing this course the learners will be able to:

1. To learn the scientific method of setting an aquarium.
2. To learn the culture breeding and marketing techniques of common indigenous ornamental fishes.
3. To learn about feeding mechanism for ornamental fishes.
4. To learn about pathology of ornamental fishes.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	-	3	-	3	-	1
CO2	2	3	-	1	2	-	2	2	1
CO3	1	2	1	1	2	2	2	1	-
CO4	2	1	1	2	2	1	1	2	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Tutorial + Practical

Unit 1: Designing and preparation of aquaria with all accessories 13 Lectures

Design and construction of aquaria: aquarium fabrication- shape, size, volume, type of glass tank, preparation of glass tank; aquarium floor setting – type and size of pebbles, gravels, granites used for bed setting and its advantages. Filters- biological, chemical and mechanical. Aquarium accessories like aerators, decorative, lighting, heating and feeding trays. Water quality management in aquarium systems – sources of water, containers, storage, temperature, pH, dissolved carbon dioxide, ammonia, hardness, turbidity in aquarium. Aquarium plants: Uses of aquarium plants, different varieties of plants.

Unit 2: Common fresh water ornamental fishes 12 Lectures

Fresh water ornamental fishes: Common ornamental fishes- indigenous and exotic species; Identification and biology of the common ornamental fishes. *Cyprinus carpio* (koi carp), *Molliensias phenops* (black molly lyre tail), *Poecilia reticulata* (guppy), *Poecilia latipinna*, *Xiphophorous helleri* (red sword tail) *Xiphophorous maculatus* (red platy) *Pterophyllum scalare* (angel fish) *Carassius auratus* (red oranda) *Betta splendens* (Siamese fighting fish) *Trichogaster leeri* (pearl gourami). Live bearers and egg layers.

Unit 3: Important indigenous ornamental fishes 13 Lectures

Indigenous ornamental fishes - Common indigenous ornamental fishes. Identification and biology of the common ornamental fishes. Cyprinids: *Puntius denisonii* (red line torpedo fish), *Puntius fasciatus* (melan barb), *Puntius filamentosus* (Indian tiger barb), *Puntius curmuca* (red tailed silver shark), *Danio malabaricus* (Malabar danio); Loaches: *Nemacheilus triangularis* (Zodiac loach), *Lepidocephalus thermalis* (Malabar loach); Cichlids: *Etroplus maculatus* (yellow and orange chromides), *E. suratensis* (pearl spot), Anabantids: *Anabas testudineus* (climbing perch) and Catfishes: *Horabagrus brachysoma* (Yellowish catfish), *H. nigricollaris* (White collared imperial catfish).

Unit 4: Management of the brood stock**13 Lectures**

Breeding and rearing of common ornamental fishes. Conditions for breeding- pH, temperature and sex ratio. Brood stock management- selection of brooders, maintenance and management of brood stocks. Induced breeding. Colour enhancement techniques. Food and feeding - live feed and formulated feed. Preparation and culture of live feed (Artemia, Infusoria, Spirulina). Control of algal growth, snails and other predators. Common disease of ornamental aquarium fishes - their causative agents - virus, bacteria, fungi, protozoa and nematode; symptoms, treatment.

Suggested readings

1. Axelrod, H.R. (1967). Breeding aquarium fishes, T F H Publications.
2. Mills, D. (1981). Aquarium Fishes, Arco publishing.
3. Mills, D. and Vevers, G. (1982). The Practical encyclopedia of fresh water, Tropical Aquarium fishes, Salamander Books limited, London.
4. Gahlawat, S.K., et.al. (2007). Manual of experimental Ichthyology, Daya publishing House, Delhi.
5. Brunner, G. (1973). Aquarium plants, T F H Publications, Inc. Ltd., Hongkong.
6. Hansen, J. (1979). Making your own aquarium, Bell and Hyman Ltd., London.
7. Lovell, T. (1998). Nutrition and feeding of fish second Ed. Kluwer Academic publishers.
8. Talwar, P.K., and Jhingran, A.G. (1991). Inland fishes Oxford and IBH Publishing Co. PVT LTD, New Delhi.

Vocational Courses: ZOUCVOT1 and ZOUCVOL1

Semester	Vocational Course	Course Title	Credits
III	VOC-2	Histological Techniques and Light Microscopy	Tutorial: 01 Practical: 03

About the course

This is the laboratory based course. It has full hands on approach to expose the students to learn techniques and methodologies for histo-pathological features. The course provides a detailed insight into basic concepts of cellular structure and function as well as tissue organization.

Learning outcomes

After successfully completing this course, the students will be able to

- ☐ Understand how tissues are preserved using fixatives.
- ☐ Understand the functioning of microtome for scanning of tissue samples.
- ☐ Acquire the detailed knowledge of different histochemical techniques related to cell components.
- ☐ Acquire brief knowledge of different staining methods for enzymatic studies.
- ☐ Develop an understanding how cells work in healthy and diseased states
- ☐ Develop skill on working of light microscope to differentiate healthy and diseased states of tissues.

Course Outcomes and their mapping with Programme Outcomes

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	3	3	3	1	1
CO2	3	3	3	1	3	3	3	1	1
CO3	3	3	3	1	3	3	3	1	1
CO4	3	3	3	1	3	3	3	1	1
CO5	3	3	3	1	3	3	3	1	1

Weightage: 1- Slightly; 2- Moderately; 3- Strongly

Theory

Unit 1: Fixation and tissue processing

Types of fixatives, Chemistry of fixation, Choice of fixatives, Dehydration, Clearing and embedding. Microtomy: Types of microtome, Sectioning of paraffin blocks.

Unit 2: Principle and methods of staining

Dyes and stains, Mordents, Histological stains: haematoxylin and eosin. Principles and methods of histochemical localization:

Unit 3: Staining methods for major cell components

Glycogen and glycoproteins by periodic acid Schiff's method, Glycoproteins by alcian blue methods, General lipids by Sudan black B method Neutral lipids by Sudan III and Sudan IV methods.

Unit 4: Advanced staining methods for nucleic acids and enzymes

Methyl green pyronin-Y for DNA and RNA, Feulgen reaction for DNA. Protein end groups: General protein localization by bromophenol blue method; $-NH_2$ groups by Ninhydrin-Schiff method. Detection of enzyme activity: Acid / alkaline phosphatases.

Unit 5: Microscopy:

Basic principle, Types of microscope and their biological applications, Bright-field microscope: numerical aperture, limit of resolution, types of objectives, ocular and stage micrometers, Transmission and scanning electron microscope.

Practical

1. To study technique for fixation of tissue using laboratory samples
2. To study tissue processing techniques: dehydration, clearing and embedding of tissue.
3. Sectioning and spreading of sections using soft tissues
4. Histological staining of paraffin sections using hematoxylin and eosin method.
5. Preparation of permanent slide of various soft of tissues.
6. Histo-chemical staining of sections for glycogen/glycoproteins/lipids
7. Histo-chemical staining for nucleic acid.
8. Histo-chemical staining for enzymatic studies.
9. Working and principle of ocular micrometer.
10. Cell counting techniques using light microscope.
11. Study of structure of prepared permanent slide using light microscope.
12. Study of ultra-structure of liver/kidney/brain using PPT/Chart.

Books Recommended

- 1 Bancroft & Stevens: Theory and Practice of Histological techniques (2002, Churchill-Livingstone)
2. Casselman: Histochemical techniques (1959, John Wiley)
3. Pearse: Histochemistry: Theoretical and Applied (Vol. I, II & III) (4th ed 1980-1993, Churchill- Livingstone).

Vocational Courses: ZOUDVOT1 and ZOUDVOL1

Semester	Vocational Course	Course Title	Credits
IV	VOC-3	Medical Diagnostics	Tutorial: 01 Practical: 03

Course Outcomes

This paper is focused to provide students an opportunity to study how clinicians come to a conclusion regarding disease prediction, prevention, diagnosis, and optimal treatment regimens. Students will learn about multiple diagnostic tools, techniques and technologies used in medical practices. The emphasis is on, how to select an appropriate diagnostic technique, methods and technologies to conduct analyses to understand the results and their implications in patients' diagnosis. This paper mainly focuses on clinical chemistry, hematology, diagnostic microbiology, histopathology, molecular diagnostics and diagnostic medical imaging.

Learning outcomes

1. Gain knowledge about diagnosis of various infectious, non-infectious and lifestyle diseases.
2. Understand the use of histology and biochemistry of clinical diagnostics.
3. Develop their skills in various types of tests and staining procedure involved in hematology.
4. Learn scientific approaches/techniques used in the clinical laboratories to investigate various diseases and will be skilled to work in research laboratories.
5. Acquire knowledge about common imaging technologies and their utility in the clinic to diagnose a specific disease.

COs	POs						PSOs		
	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	3	1	2	-	3	2	1
CO2	3	3	3	1	1	-	3	2	1
CO3	3	3	2	-	1	-	3	2	-
CO4	3	2	2	-	-	-	3	1	-
CO5	3	2	1	-	-	-	3	1	-

Unit 1: Introduction to medical diagnostics and its importance

5 Lectures

Identification of common equipment, principle and care of laboratory instruments. Basic needs of clinical laboratory technician, awareness of soft skills. NABL and SOP. Basic causes Personnel care and protection

Unit 2: Maintenance & equipment of pathology lab

5 Lectures

Materials, Equipment & Techniques. Reagents – Preparation and their uses. Personnel care and protection Disposal of Bio-Medical waste. Sample Collection, Preservation & Labeling of Slides, Blocks, Specimens. Clinical Samples Fixatives. Preservation of reports & records.

Unit 3: Collection of specimen and disposal of waste

5 Lectures

General principles, containers, rejection. Samples-Urine, Faeces, Sputum, Pus, Body Fluids, Swab, Blood. Importance of biomedical waste. Disposal of laboratory/hospital waste. Non-infectious waste, infected sharp waste disposal, infected non-sharp waste disposal.

Unit 4: Basic haematological techniques

5 Lectures

Basic steps for drawing blood by vein, capillary and artery puncture. Complications during and after blood collection. Specimen rejection criteria for blood. Anticoagulants types and concentration. Transport of blood sample. Blood composition, Preparation of blood smear and blood cell counting.

Unit 5: Diagnostic methods used for urine analysis

5 Lectures

Urine analysis: Urine collection, preservation. Physical examination of urine, Abnormal constituents, Urine culture. Urinary tract infection, kidney disease and diabetes. Urine analysis for Chemicals, Sugar, Ketone Bodies, Bile, Blood, Crystals.

Practical

1. Identification of common equipment, principle and care of laboratory instruments.
2. Demonstration of estimation of haemoglobin.
3. Preparation of haemin and haemochromogen crystals.
4. Counting of RBCs and WBCs using Haemocytometer.
5. To study different mammalian blood cell types using Leishman stain.
6. Recording of blood pressure using a sphygmomanometer.
7. Recording of blood glucose level by using glucometer.
8. Test for sugar and acetone in urine.
9. Vaginal & Buccal smear preparation and analysis.
10. Processing of the tissues including Bone. Embedding, Section Cutting, Staining & Mounting.
11. Visit to pathology lab.

Suggested readings

1. Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
2. Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
3. Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
4. Guyton A.C. and Hall J.E. *Textbook of Medical Physiology*, Saunders
5. Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
6. Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co.Ltd.