

## **Syllabus of FYUGP-Zoology**



**Approved in the BOS held on 04<sup>th</sup> June 2024**  
**DIBRUGARH UNIVERSITY**  
**Dibrugarh, Assam**  
**786004**

# **FOUR YEAR UNDER-GRADUATE PROGRAMME (FYUGP) IN ZOOLOGY, DIBRUGARH UNIVERSITY**

## **1. The Preamble:**

Present-day zoology is a fusion of the traditional components with the modern aspects of biochemistry, molecular biology and biotechnology. Over the years, Zoology has shown enormous gain in information and applications owing to tremendous inputs from research in all its aspects. With the global need for conservation, field biologists have contributed significantly in assessing and exploring newer dimensions for animal diversity. New insights on various dimensions of the zoological world have been gained by utilizing modern tools and techniques for zoological research. Concern for ever-increasing pollution and climate change is at its highest than ever before. Keeping the above-mentioned advancements and rich resources in North East India in view, a revised curriculum is offered by Dibrugarh University at the undergraduate level as per the National Education Policy-2020 so that the undergraduate Zoology students of Dibrugarh University shall have the benefit of a balanced, carefully-crafted course structure taking care of different aspects of zoology, namely animal diversity, physiology, cell biology, genetics, evolution, biochemistry, molecular biology, developmental biology, reproductive physiology, comparative anatomy, chronobiology, ecology and economic zoology. All these aspects have been given due weightage over the eight semesters. The undergraduate students need to acquaint themselves with various tools and techniques for exploring the world of animals. Keeping view of employment entrepreneurship, skill based courses of sericulture and aquaculture have been introduced. These courses shall provide the students hands on experience and professional inputs. On the whole, the curriculum is a source of lot of information and is supported by rich resource materials. It is hoped that a student graduating in Zoology with the new curriculum will be able to explore the rich animal diversity of North East India.

## **2. Introduction:**

Dibrugarh University UG syllabus of Zoology is designed as per the guidelines of National Education Policy-2020. This Four Year Under Graduate Programme (FYUGP) in Zoology consists of Major (Core) disciplines, Minor disciplines, Multi Disciplinary Generic Elective Courses (GE), Ability Enhancement Courses (AEC), Value Added Courses (VAC), Skill Enhancement Courses (SEC), Environmental Education (EE), YOGA, Community Engagement like NCC/NSS, Digital and Technological solutions, Internship, Field Studies, Research Ethics, Research Projects and Discipline Specific electives (DSE) to acquaint the students with balanced knowledge on the animal resources, environment, contemporary issues and entrepreneurship.

The Bachelor of Science in Zoology of Dibrugarh University under NEP-2020 is a programme with multiple exit options. UG certificate, UG Diploma, UG Degree and UG Degree (Honours with Research) in Zoology will be awarded to students after successful completion of one, two, three and four years respectively. It is expected that, on successful completion of this four year programme students will be skilled in multidisciplinary aspects for exploration and sustainable utilization of natural resources of NE

region of India.

### **3. Aims of Four Year Under-Graduate Programme (FYUGP) in Zoology:**

1. To introduce the students with the rich world of animal diversity with a focus on biodiversity of North east India.

2. To enable the students to explore the potential of natural resources for human welfare and their use in a sustainable way.

3. To develop capabilities of students for critical evaluation of contemporary issues related to environment and conservation.

4. To generate skilled human resources for biological entrepreneurship.

### **4. Graduate Attributes of the FYUGP in Zoology:**

#### ***Disciplinary Knowledge***

The graduates should have the ability to demonstrate comprehensive knowledge and understanding of both the theoretical and applied components of animal science and allied areas of study in a multidisciplinary context.

Students should have the ability to connect relevant disciplines, and recent trends in biological and contemporary issues.

#### ***Communication Skills***

The graduates in Zoology should have the ability to present and express information, thoughts, experiments and results clearly and concisely for effective communication of any issues related to animals and nature.

#### ***Moral and Ethical Awareness/Reasoning***

Ability to recognise ethical issues that are pertinent to one's work and pledge not to engage in unethical behaviour such as plagiarism, copyright and infringement of intellectual property rights; ability to appreciate recent developments in various fields and one's research with honesty and integrity in all aspects.

#### ***Multicultural Competence***

Ability to correlate and compare recent developments in various branches of animal science worldwide; ability to collaborate research in various fields of biology with other researchers from allied organisations; acquisition of knowledge on traditional practices of different ethnic communities.

#### ***Information/Digital Literacy***

The graduates of Zoology should have the ability to utilize Information and Communications Technology (ICT) tools, biological databases and computer and softwares in solving biological problems.

#### ***Reflective Thinking and Problem Solving:***

After completion of graduation in Zoology the students will be able to understand the value of animal diversity, need for conservation of animals, bio-prospecting and sustainable utilization of natural resources for human welfare.

### ***Critical Thinking***

The graduates of Zoology should be competent for critical analysis of problems related to animals and nature, sustainable uses of biological resources and their conservation strategies.

#### **5. Programme Educational Objectives (PEOs)**

- 1) Formulate strategies to achieve sustainable development in harnessing biological resources.
- 2) Evaluate environmental problems and design innovative solutions.
- 3) Demonstrate an attitude to employ multidisciplinary approaches for problem solving.

#### **6. Programme Outcomes (POs)**

- 1) Develop ideas to assess and inventorize existing biological resources of this region
- 2) Formulate innovative strategies for conservation of biogenetic resources for human welfare
- 3) To explore and validate ethnobiological knowledge of Northeast India
- 4) To provide solutions for existing societal problems using biological knowledge
- 5) Develop research skills to solve complex biological issues and achieving SDGs
- 6) Execute good communication skills for disseminating knowledge of biological sciences
- 7) To promote the attitude to work as a team appreciating ethical values

#### **7. Programme Specific Outcomes (PSOs)**

- 1) Evaluate the diversity and evolution of organisms
- 2) Analyze the fundamentals of life-sustaining processes
- 3) Design strategies for issues concerning public health and human welfare
- 4) Critically analyze the environmental issues and develop strategies to address them
- 5) Formulate measures to mitigate climate change effects

Semester	Course	Course Name	Credit
I	CORE-I	Animal Diversity I	4
	Minor I	Animal Diversity I- Minor	4
	GEC – 1	Natural resource management	3
	AEC 1	Modern Indian Language	4
	VAC 1	Understanding India	2
	SEC I	a) Freshwater Aquaculture/ b) Apiculture	3
<b>Total</b>			<b>20</b>
II	CORE-II	Animal Diversity II	4
	Minor II	Animal Diversity II – Minor	4
	GEC II	Wildlife Conservation and Management	3
	AEC II	English Language and Communication Skills	4
	VAC II	Environmental Science	2
	SEC II	a) Sericulture/ b) Aquarium Fish Keeping	3
<b>Total</b>			<b>20</b>
III	Core-III	Cell Biology	4
	Core-IV	Comparative Anatomy of Vertebrates	4
	Minor-III	Comparative Anatomy of Vertebrates	4
	GEC-III	Insect vectors and Diseases	3
	SEC-III	a) Vermicomposting/ b) Medical Diagnostics	3
	VAC III	Digital and Technological Solutions / Digital Fluency	2
<b>Total</b>			<b>20</b>
IV	CORE-V	Biochemistry and Molecular Biology	4
	CORE-VI	Animal Physiology	4
	CORE-VII	Genetics and Evolutionary Biology	4
	CORE-VIII	Lab Course on C-V,VI,VII	4
	Minor	Fundamentals of Animal Physiology	4
	<b>TOTAL CREDIT</b>		<b>20</b>
V	CORE-IX	Developmental Biology	4
	CORE-X	Animal Behaviour and Chronobiology	4
	CORE-XI	Animal Biotechnology and	4

		techniques in biology	
	Minor	Animal Biotechnology and techniques in biology- Minor	4
		Field Study/ Internship/Community Engagement-NSS/NCC	4
	<b>TOTAL CREDIT</b>		<b>20</b>
VI	CORE-XII	Animal Physiology : Controlling and Co-ordinating Physiology	4
	CORE-XIII	Animal Ecology and Wildlife Management	4
	CORE-XIV	Bioinformatics and Biostatistics	4
	CORE-XV	Lab Course on C-XII,XII,XIV	4
	Minor	Animal Physiology : Controlling and Co-ordinating Physiology – Minor	4
	<b>TOTAL</b>		<b>20</b>

## SEMESTER I

**Title of the Course** : Animal Diversity I  
**Course Code** :  
**Nature of the Course** : CORE I  
**Total Credits** : 04  
**Distribution of Marks** : 100 ( 60 End + 40 IA)

### COs:

- 1) Describe different phyla in animal kingdom
- 2) Organize the organisms in different categories based on morphological characteristics
- 3) Analyze the interrelationship among different species and genera within each group of animals

### Learning Outcomes:

- 1) Understand the various phyla in Animal Kingdom
- 2) Compare various organisms based on morphology
- 3) Classify different groups of animals

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2, CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### MODES OF IN-SEMESTER ASSESSMENT:

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.

- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

UNIT	CONTENT	L	T	P	Total
1	<b>Protista, Parazoa and Metazoa</b> General characteristics and Classification up to Classes Structural organization & nutrition of <i>Amoeba</i> , <i>Euglena</i> , and <i>Paramecium</i> . Locomotion and Reproduction in Animal protista (Protozoa)	10	2	-	12
2	<b>Porifera, Cnidaria &amp; Ctenophora</b> General characteristics and Classification up to classes with examples Canal system in sponges and Evolutionary significance	7	1	-	8
3	<b>Platyhelminthes &amp; Nematelminthes</b> General characteristics and Classification up to classes Life cycle of <i>Taenia solium</i> , <i>Fasciola hepatica</i> and <i>Ascaris lumbricoides</i> Parasitic adaptation in Helminths.	7	1	-	8
4	<b>Introduction to Coelomates, Annelida and Arthropods</b> Evolution of coelom and metamerism General characteristics and Classification up to classes Excretion in Annelida. Respiration in Arthropoda	8	1	-	9
5	<b>Onychophora &amp; Mollusca and Echinodermata</b> General characteristics Classification up to classes Torsion and detorsion in Gastropoda Water-vascular system in Asteroidea	7	1	-	8



6	<p>1) Study of the following specimens:  Protista: Amoeba, Euglena, Plasmodium, Paramecium  Cindaria: Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora and One specimen/slide of anyctenophore  Annelids: Neries, Aphrodite, Chetopterus, Pheretima, Hirudanaria  Arthropods: Limulus, Belastoma, Palamnaeus, Daphnia, Palaemon, Cance, Brachionus Bombyx, Periplaneta, Samia ricini. Antherae spp. Termite and honey bee.  Helminths: Ascaris, Taenia, Fasciola.  Molluscs: Chiton, Dentalium, Pila, Doris, Helix, Unio, Sepia, Octopus and Nautilus.  Echinoderms: Pentaceros, Asterias, Ophiura, Echinus, Antedon</p> <p>2) Study of <i>Sycon</i>(T.S. and L.S.), <i>Hyalonema</i>, <i>Euplectella</i>, <i>Spongilla</i></p> <p>3) Study of whole mount of <i>Euglena</i>, <i>Amoeba</i> and <i>Paramecium</i>, Binary fission and Conjugation in <i>Paramecium</i>.</p> <p>4) Study of mouth parts of periplaneta</p> <p>5) Study of adult <i>Fasciola hepatica</i>, <i>Taenia solium</i> and their life cycles (Slides/micro- photographs)</p> <p>6) Study of adult <i>Ascaris lumbricoides</i> and its life stages (Slides/micro-photographs).</p> <p>7) Study of septal nephridia in earthworm, digestive system of periplaneta (virtual).</p>	-	-	15	15
		39	6	15	60

### Suggested Readings

1. Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
2. Kingsley J. Text Book of Vertebrate Zoology Publisher: Nabu Press ISBN: 9781171586524, 1171586523
3. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrate

## SEMESTER I

**Title of the Course** : Animal Diversity I Minor  
**Course Code** :  
**Nature of the Course** : Minor-I  
**Total Credits** : 04  
**Distribution of Marks** : 100 ( 60 End + 40 IA)

### COs:

1. Describe different phyla in animal kingdom
2. Organize the organisms in different categories based on morphological characteristics
3. Analyze the interrelationship among different species and genera within each group of animals

### Learning Outcomes:

1. Understand the various phyla in Animal Kingdom
2. Compare various organisms based on morphology
3. Classify different groups of animals

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### MODES OF IN-SEMESTER ASSESSMENT:

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied

specimens.

- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

UNIT	CONTENT	L	T	P	Total
1	<b>Protista, Parazoa and Metazoa</b> General characteristics and Classification up to Classes Structural organization & nutrition of <i>Amoeba</i> , <i>Euglena</i> , and <i>Paramecium</i> . Locomotion and Reproduction in Animal protista (Protozoa)	10	2	-	12
2	<b>Porifera, Cnidaria &amp; Ctenophora</b> General characteristics and Classification up to classes with examples Canal system in sponges and Evolutionary significance	7	1	-	8
3	<b>Platyhelminthes &amp; Nematelminthes</b> General characteristics and Classification up to classes Life cycle of <i>Taenia solium</i> , <i>Fasciola hepatica</i> and <i>Ascaris lumbricoides</i> Parasitic adaptation in Helminths.	7	1	-	8
4	<b>Introduction to Coelomates, Annelida and Arthropods</b> Evolution of coelom and metamerism General characteristics and Classification up to classes Excretion in Annelida. Respiration in Arthropoda	8	1	-	9
5	<b>Onychophora &amp; Mollusca and Echinodermata</b> General characteristics Classification up to classes Torsion and detorsion in Gastropoda Water-vascular system in Asteroidea	7	1	-	8
6	1) Study of the following specimens: Protista: <i>Amoeba</i> , <i>Euglena</i> , <i>Plasmodium</i> , <i>Paramecium</i> Cnidaria: <i>Obelia</i> , <i>Physalia</i> , <i>Millepora</i> , <i>Aurelia</i> , <i>Tubipora</i> , <i>Corallium</i> , <i>Alcyonium</i> , <i>Gorgonia</i> , <i>Metridium</i> , <i>Pennatula</i> , <i>Fungia</i> , <i>Meandrina</i> , <i>Madrepora</i> and One specimen/slide of anyctenophore Annelids: <i>Neries</i> , <i>Aphrodite</i> , <i>Chetopterus</i> , <i>Pheretima</i> , <i>Hirudanaria</i> Arthropods: <i>Limulus</i> , <i>Belastoma</i> , <i>Palamnaeus</i> , <i>Daphnia</i> , <i>Palaemon</i> , <i>Cance</i> , <i>Brachionus</i> , <i>Bombyx</i> , <i>Periplaneta</i> , <i>Samia ricini</i> . <i>Antherae</i> spp. Termite and honey bee.	-	-	15	15

	<p>Helminths: Ascaris, Taenia, Fasciola.  Molluscs: Chiton, Dentalium, Pila, Doris, Helix, Unio, Sepia, Octopus and Nautilus.  Echinoderms: Pentaceros, Asterias, Ophiura, Echinus, Antedon</p> <p>2) Study of <i>Sycon</i> (T.S. and L.S.), <i>Hyalonema</i>, <i>Euplectella</i>, <i>Spongilla</i></p> <p>3) Study of whole mount of <i>Euglena</i>, <i>Amoeba</i> and <i>Paramecium</i>, Binary fission and Conjugation in <i>Paramecium</i>.</p> <p>4) Study of mouth parts of periplaneta</p> <p>5) Study of adult <i>Fasciola hepatica</i>, <i>Taenia solium</i> and their life cycles (Slides/micro-photographs)</p> <p>6) Study of adult <i>Ascaris lumbricoides</i> and its life stages (Slides/micro-photographs).</p> <p>7) Study of septal nephridia in earthworm, digestive system of periplaneta (virtual).</p>				
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**Suggested Readings**

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## SEMESTER I

**Title of the Course : Natural resource management**

**Course Code :**

**Nature of the Course: Generic Elective Course-I**

**Total Credits 03**

**Distribution of Marks: 75 (45 End + 30 IA)**

### COs:

1. Distinguish between renewable and non-renewable resources
2. Analyse threats to natural and biological resources of NE India
3. Examine management strategies for sustainable utilization of resources

### Learning outcomes:

1. Differentiate natural and biological resources of NE India
2. Identify the threats and issues related to the natural resources
3. Execute conservation and management strategies for natural resources

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2, CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment:

1. Internal examination
2. Group discussion/ Home assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination

UNIT	CONTENT	L	T	P	Total
1	<b>Natural resources:</b> Definition and types. Natural resources of NE India. Renewable and non-renewable sources of energy.	7	-	-	7
2	<b>Sustainable utilization of land and water resources:</b> Soil degradation and management; water resources (Freshwater, marine, estuarine) wetlands; Threats and management strategies and their management.	15	-	-	15
3	<b>Biodiversity:</b> Definition, types, significance, threats, management strategies, CBD, Bioprospecting	8	-	-	8
4	<b>Contemporary practices in resource management:</b> EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management. National and international efforts in resource management and conservation.	15	-	-	15
		45	-	-	45

#### SUGGESTED READINGS:

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

## SEMESTER I

<b>Title of the Course</b>	:	<b>Freshwater Aquaculture</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>SEC I a</b>
<b>Total Credits</b>	:	<b>03</b>
<b>Distribution of Marks</b>	:	<b>75 (45 End + 30 IA)</b>

### COs:

1. Analyze concept of freshwater aquaculture.
2. Evaluate the technique of fish rearing, transportation and the technique of induced breeding.
3. Discuss the maintenance of fish health.

### Learning Outcomes:

- Understand the freshwater aquaculture concept.
- Analyze fishing gears and induced breeding techniques.
- Identify fish diseases.

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3		
Procedural					CO2	
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	1	1	1.8
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	2	1	1	2	2	1.8
AVERAGE	3	2	2.0	1.7	1.7	1.7	1.7	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment:

1. One theory Internal examination
2. One practical Internal examination
3. Viva-voce/ Home assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

## Course content

UNITS	CONTENTS	L	T	P	Total Hours
1	Introduction to Aquaculture, Basic concept of extensive, intensive and superintensive aquaculture, monoculture, polyculture and integrated farming.	5	1	-	6
2	Rearing of Larval and brood fishes, Traditional and Chinese hatcheries, feed preparation for carps and catfishes, Live food culture, Transportation of fish seeds and brooders.	7	1	-	8
3	Concept of induced breeding, ornamental fish, Captive breeding of carp, catfishes, Diagnostic characters of brood fishes and ornamental fishes, Breeding of carps and catfishes in simulated environments, Standardisation of hormonal doses.	7	1	-	8
4	Maintenance of fish health and prophylactic measures, Diagnostic of common fungal, bacterial, protozoan and ectoparasites, Control measures for common fish diseases, Role of immunostimulants in aquaculture.	6	2	-	8
5	<b>Practicals:</b> 1) Study of fishing gears 2) Basic symptoms of fish diseases Demonstration of Induced Breeding	-	-	15	15
	<b>TOTAL</b>	<b>25</b>	<b>5</b>	<b>15</b>	<b>45</b>



*Where,*

*L: Lectures*

*T: Tutorials*

*P: Practicals*

### **SUGGESTED READINGS**

- D. Kapoor, R. Dayal and A.G. Ponniah: Fish Biodiversity of India, NBFGR Publication, Lucknow.
- R.H. McConnell: Ecological Studies in Tropical Fish Communities, Cambridge University Press.
- Matty: Fish Endocrinology.
- T.K. Govindan: Fish Processing Technology, Oxford & IBH, New Delhi
- Fish and Fisheries - S.S. Khanng
- Fresh Water Aquaculture – Rath
- Hand Book of fish and Fisheries - ICAR

## SEMESTER I

<b>Title of the Course</b>	:	<b>APICULTURE</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>SEC IIb</b>
<b>Total Credits</b>	:	<b>03</b>
<b>Distribution of Marks</b>	:	<b>75 (45 END +30 IA)</b>

### COs:

1. Discuss the concept of apiculture
2. Analyze bee rearing process and tools used in bee keeping
3. Analyze the bee diseases

### Learning Outcomes:

- Understand about apiculture
- Apply the knowledge the bee rearing process for commercial purposes
- Identify the health of bees

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2, CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

- One theory Internal examination
- One practical Internal examination
- Viva-voce/ Home assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total Hours
1	<b>Biology of Bees</b> History, Classification and Biology of Honey Bee species, Social Organization of Bee Colony, Bee plants	5	-	-	5
2	<b>Rearing of Bees</b> Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth, Bee Pasturage, Selection of Bee Species for Apiculture, Bee Keeping Equipment, Methods of Extraction of Honey (Indigenous and Modern)	5	-	-	5
3	<b>Diseases and Enemies</b> Bee Diseases and Enemies Control and Preventive measures	10	-	-	10
4	<b>Bee Economy and Entrepreneurship in Apiculture</b> Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens	10	-	-	15
5	1) Draw a diagram by observing mouth parts of a worker bee under microscope. 2) Check a bee colony and note variations in the size and shape of a worker, drone and queen. Measure the body size (length of body and wing size) 3) Note special features of fore leg, middle leg and hind leg of the worker bee and wing coupling apparatus 4) Follow a returning forager and observe its activities in side a colony in an observation hive. 5) Check a brood frame containing brood and honey and differentiate between: sealed brood and sealed honey; sealed worker and drone brood if present Remove sealed frames of honey, uncap using uncaping knife and extract honey using honey extractor	-	-	15	15
	<b>TOTAL</b>	<b>30</b>	<b>-</b>	<b>15</b>	<b>45</b>

## SEMESTER II

**Title of the Course** : **Animal Diversity II**  
**Course Code** :  
**Nature of the Course** : **CORE II**  
**Total Credits** : **04**  
**Distribution of Marks** : **100 ( 60 End + 40 IA)**

### COs:

1. describe different phyla in animal kingdom
2. organize the organisms in different categories based on morphological characteristics
3. analyze the interrelationship among different species and genera within each group of animals

### Learning Outcomes:

- 1) understand the various phyla in Animal Kingdom
- 2) compare various organisms based on morphology
- 3) classify different groups of animals

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### MODES OF IN-SEMESTER ASSESSMENT:

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.

- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total
1	<p><b>Introduction to Chordates:</b> General characteristics and outline classification</p> <p><b>Protochordata:</b> General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata</p> <p><b>Origin of Chordata:</b> Theories of origin of chordates, Advanced features of vertebrates over Protochordata</p>	10	1	-	11
2	<p><b>Agnatha and Pisces:</b></p> <p>Agnatha: General characteristics and classification of cyclostomes up to class with example</p> <p>Pisces: General characteristics of Chondrichthyes and Osteichthyes, classification up to order Osmoregulation</p>	8	1	-	9
3	<p><b>Amphibia &amp; Reptilia</b></p> <p>Amphibia: Origin of <i>Tetrapoda</i> (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Reptilia: General characteristics and classification up to order; Affinities of <i>Sphenodon</i>; Poison apparatus and Biting mechanism in snakes</p>	8	1	-	9
4	<p><b>Aves &amp; Mammals</b></p> <p>Aves: General characteristics and classification up to order <i>Archaeopteryx</i>-- a connecting link; Principles and aerodynamics of flight, Flight adaptations</p> <p>Mammals: General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages</p>	8	1	-	9
5	<p><b>Zoogeography</b></p> <p>Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms</p>	7	-	-	7

6	<p>1. To study the following specimen:  <b>Protochordata;</b> Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata. Sections of Balanoglossus through proboscis and branchiogenital regions,  <b>Fishes;</b> <i>Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetradon/ Diodon, Anabas, Flat fish, Channa spp. Puntius spp. Trichogaster, Heteropneusteus spp., Clarias spp., Mystus spp.</i>  <b>Amphibia;</b> <i>Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandr</i>  <b>Reptilia;</b> <i>Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus</i>  <b>Aves;</b> Study of six common birds from different orders.  <b>Mammalia;</b> Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous.</p> <p>2. Dissection of weberian ossicles of <i>Mystus</i>.</p> <p>3. To study and prepare a chart of keys of identification of poisonous and non- poisonous snakes.</p> <p>4. Study of animal organ system: Urinogenital System of fish (locally available fish).</p> <p>5. Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmania spicules, Placoid and Cycloid Scales in Fishes, Types of beaks and claws, pecten from Fowlhead .</p> <p>6. To submit a Project Report on any related topic to larval forms.</p>	-	-	15	15
	TOTAL	41	4	15	60

### Suggested Readings

- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford universitypress.
- Pough H. *Vertebrate life*, VIII Edition, PearsonInternational.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger PubCo.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett PublishersInc.

## SEMESTER II

**Title of the Course** : **Animal Diversity II Minor**  
**Course Code** :  
**Nature of the Course** : **Minor II**  
**Total Credits** : **04**  
**Distribution of Marks** : **100 ( 60 End + 40 IA)**

### COs:

- 1) describe different phyla in animal kingdom
- 2) organize the organisms in different categories based on morphological characteristics
- 3) analyze the interrelationship among different species and genera within each group of animals

### Learning Outcomes:

1. understand the various phyla in Animal Kingdom
2. compare various organisms based on morphology
3. classify different groups of animals

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1		CO2,CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### MODES OF IN-SEMESTER ASSESSMENT:

- One Theory exam
- One Practical exam
- Group Discussion/Seminar/Viva/Assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination based on identification of supplied specimens.
- Submission of practical file with record of studied specimens
- Submission of collected specimens
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total
1	<p><b>Introduction to Chordates:</b> General characteristics and outline classification</p> <p><b>Protochordata:</b> General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata</p> <p><b>Origin of Chordata:</b> Theories of origin of chordates, Advanced features of vertebrates over Protochordata</p>	10	1	-	11
2	<p><b>Agnatha and Pisces:</b></p> <p>Agnatha: General characteristics and classification of cyclostomes up to class with example</p> <p>Pisces: General characteristics of Chondrichthyes and Osteichthyes, classification up to order Osmoregulation</p>	8	1	-	9
3	<p><b>Amphibia &amp; Reptilia</b></p> <p>Amphibia: Origin of <i>Tetrapoda</i> (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Reptilia: General characteristics and classification up to order; Affinities of <i>Sphenodon</i>; Poison apparatus and Biting mechanism in snakes</p>	8	1	-	9
4	<p><b>Aves &amp; Mammals</b></p> <p>Aves: General characteristics and classification up to order <i>Archaeopteryx</i>-- a connecting link; Principles and aerodynamics of flight, Flight adaptations</p> <p>Mammals: General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages</p>	8	1	-	9
5	<p><b>Zoogeography</b></p> <p>Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms</p>	7	-	-	7



6	<p>1. To study the following specimen:  <b>Protochordata;</b> Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata. Sections of Balanoglossus through proboscis and branchiogenital regions,  <b>Fishes;</b> <i>Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetraodon/ Diodon, Anabas, Flat fish, Channa spp. Puntius spp. Trichogaster, Heteropneusteus spp., Clarias spp., Mystus spp.</i>  <b>Amphibia;</b> <i>Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandr</i>  <b>Reptilia;</b> <i>Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus</i>  <b>Aves;</b> Study of six common birds from different orders.  <b>Mammalia;</b> Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous.</p> <p>2. Dissection of weberian ossicles of <i>Mystus</i>.</p> <p>3. To study and prepare a chart of keys of identification of poisonous and non- poisonous snakes.</p> <p>4. Study of animal organ system: Urinogenital System of fish (locally available fish).</p> <p>5. Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmania spicules, Placoid and Cycloid Scales in Fishes, Types of beaks and claws, pecten from Fowlhead .</p> <p>6. To submit a Project Report on any related topic to larval forms.</p>	-	-	15	15
	TOTAL	41	4	15	60

### SUGGESTED READINGS

- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- Darlington P.J. *The Geographical Distribution of Animals*, R.E. Krieger PubCo.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

## SEMESTER II

<b>Title of the Course</b>	:	<b>SERICULTURE</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>SEC II a</b>
<b>Total Credits</b>	:	<b>03</b>
<b>Distribution of Marks</b>	:	<b>75 (45 End +30 IA)</b>

### COs:

1. Analyze the concept of sericulture.
2. Evaluate the rearing technique and associated tools.
3. Examine the diseases and learn the control measures.

### Learning outcomes:

- Understand the concept of sericulture
- Apply the rearing techniques and tools for commercial purposes
- Identify diseases of the silkworm

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3		
Procedural					CO2	
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment:

- One theory Internal examination
- One practical Internal examination
- Viva-voce/ Home assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination

- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total Hours
1	Sericulture: Definition, history and present status; Silk route Types of silkworms, Distribution and Races Exotic and indigenous races, Hybrids Mulberry and non-mulberry Sericulture Life cycle of <i>Bombyx mori</i> , <i>Antheraea assamensis</i> Structure of silk gland and secretion of silk Sex linked traits	5	-	-	5
2	Rearing of silkworms: Mulberry silkworm rearing : Selection of mulberry variety and establishment of mulberry garden Rearing house and rearing appliances Disinfectants: Formalin, bleaching powder, RKO Silkworm rearing technology: Early age and Late age rearing. Types of mountages Spinning, harvesting and storage of cocoons Non mulberry silkworm rearing: Host plants of non mulberry silkworm, maintenance of host plants of <i>Antheraea assamensis</i> , rearing technology of <i>Antheraea sppand Samia cynthia ricini</i>	5	-	-	5
3	Pests and diseases: Pests of silkworm: Uzi fly, Apanteles, dermestid beetles and vertebrates. Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial. Control and prevention of pests and diseases	10	-	-	10
4	Entrepreneurship in sericulture: Prospects of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.	10	-	-	15
5	Practicals <ul style="list-style-type: none"> <li>• Study of life cycle of different silkworms</li> <li>• Sex separation in larva, pupa and adult of silkworm</li> <li>• Anatomy of Silkworm:</li> </ul>	-	-	15	15

	<ul style="list-style-type: none"> <li>• Digestive system b) Silk gland</li> <li>• Identification of common insects associated with sericulture industry</li> <li>• Identification of different diseased silkworms based on external symptoms (Grasserie, Flacherie, Muscardine and Pebrine)</li> <li>• Identification of permanent slide of bacteria, spores of Pebrine, spores of Muscardine</li>   <li>• Identification and study Sericulture products : Silk Yarn different types, Pupae</li> <li>• Visit to field and farmers rearing house/ silk reeling establishments</li> </ul>				
	<b>TOTAL</b>	<b>30</b>	<b>-</b>	<b>15</b>	<b>45</b>

*Where,*

*L: Lectures*

*T: Tutorials*

*P: Practicals*

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### SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
- Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.
- Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988.
- Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.
- A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.
- Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986.

## SEMESTER II

<b>Title of the Course</b>	:	<b>AQUARIUM FISH KEEPING</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>SEC II b</b>
<b>Total Credits</b>	:	<b>03</b>
<b>Distribution of Marks</b>	:	<b>75 ( 45 End + 30 IA)</b>

### COs:

1. Analyze the concept of aquarium fish keeping.
2. Discuss ornamental fishes and their importance.
3. Evaluate the technique of fish feed preparation.

### Learning Outcomes:

- Explain the concept of fish keeping in aquariums
- Discuss about ornamental fishes
- Formulation of fish feeds

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2,		
Procedural					CO3	
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment:

- One theory Internal examination
- One practical Internal examination
- Viva-voce/ Home assignments

### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total Hours
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1	Introduction: The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes	5	-	-	5
2	Biology: Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish, Botia, Gourami, <i>Channa bleheri</i> , <i>Channa barca</i>	5	-	-	5
3	Food and feeding : Use of live fish feed organisms. Preparation and composition of formulated fish feeds Live fish transport - Fish handling, packing and forwarding techniques	10	-	-	10
4	Transportation and maintenance: General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry, Scope of aquarium fish industry in NE India	10	-	-	15
5	Practicals 1) Management of aquarium environment 2) Collection of ornamental fishes 3) Acclimatization of fish 4) Preparation of feed and Feeding of aquarium fish	-	-	15	15
	TOTAL	30	-	15	45

Where,

*L: Lectures*

*T: Tutorials*

*P: Practicals*

### SUGGESTED READINGS

1. G. Helfman, Bruce B. Collette, D.E. Facey, B. W. Bowen: The Diversity of Fishes: Biology, Evolution, and Ecology, John Wiley & Sons
2. R. J. Wootton: Fish Ecology, Springer
3. W. Vishwanath, W.S. Lakra and U.K. Sarkar: Fishes of North East India, NBFGR Publication, Lucknow
4. Handbook of Fisheries and Aquaculture – ICAR
5. Ornamental Fish culture and Aquarium Maintenance – AO Dholakia

### SEMESTER III

**Title of the Course** : **Cell Biology-I**  
**Course Code** :  
**Code** : **CORE-III**  
**Total Credits** : **04**  
**Distribution of Marks** : **100 ( 60 End + 40 IA)**

#### COs:

- 1) differentiate the structure and functions of cellular components
- 2) evaluate the cell division mechanism and cell cycle.
- 3) analyze cell signalling mechanism.

#### Learning Outcomes:

- 1) understand the cell structure and functions of cell organelles.
- 2) analyze cell division and cell cycle mechanisms.
- 3) interpret the cell signalling mechanisms.

#### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO3	CO2	
Procedural						
Metacognitive						

#### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

#### Modes of internal assessment

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce/Group discussion/Home assignments

#### Attainment of Cos:

1. Continuous evaluation through in and end semester theory and practical examinations
2. Laboratory practices on cells, cellular organelles and cellular processes
3. Practical record book/field book

UNITS	CONTENTS	L	T	P	Total
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1	<b>Overview of cell: Prokaryotic and Eukaryotic cells</b> Plasma Membrane and Cytoskeleton: Various models of plasma membrane structure, Transport across membranes: Active and Passive transport, Cell junctions: Tight junctions, Desmosomes, Gap junctions, Structure and Functions: Microtubules, Microfilaments and Intermediate filaments	8	2	-	10
2	<b>Endomembrane System: Structure and Functions:</b> Endoplasmic Reticulum, Golgi Apparatus, Lysosomes	8	-	-	8



3	<b>Mitochondria and Peroxisomes:</b> Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis, Peroxisomes	8	1	-	9
4	<b>Nucleus:</b> Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome).	8	1	-	9
5	<b>Cell Division and Cell Signalling</b> Mitosis, Meiosis, Cell cycle and its regulation, GPCR and Role of second messenger (cAMP).	8	1	-	9
6	<b>Lab activities</b> <ol style="list-style-type: none"> <li>1. Introduction to basic tools of biochemistry</li> <li>2. Preparation of different biochemical solutions, dilutions, preparation of buffer solutions etc.</li> <li>3. Qualitative tests of functional groups in carbohydrates, proteins and lipids, ascorbic acid, free phosphate</li> <li>4. Separation of amino acids by paper/TLC and determination of Rf value.</li> <li>5. Preparation of permanent slide to demonstrate: Mucopolysaccharides by PAS reaction Proteins by Mercurbromophenol blue/FastGreen</li> <li>6. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.</li> </ol>	-	-	15	15
		40	5	15	60

### Textbooks

1. Karp G., Cell and Molecular Biology: Concepts and Experiments, 7th Edition (John Wiley & Sons, Inc., 2013).
2. Scott, M. P. et al, Molecular Cell Biology, 6th Edition (W. H. Freeman, 2007).

3. Alberts, B. et al., Molecular Biology of the Cell, 5th Edition (Garland Publishing, 2008).
4. Becker, W. M. et al., The World of Cell, 8th Edition (Benjamin Cummings, 2011).

**Suggested Readings**

1. Molecular and Cell Biology (Schaum's Outlines series special Indian edition) by W. D. Stansfield, J. S. C. Colome, R. J. Cano and R. N. Sharan (2010), McGraw Hill Education.
2. Cooper, G. M. and Hausman, R. E., The Cell: A Molecular Approach, 5th Edition (ASM Press and Sinauer Associates, Inc., 2009).

### SEMESTER III

<b>Title of the Course</b>	:	<b>Comparative Anatomy of Vertebrates</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>Core IV</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>100 ( 60 END + 40 IA)</b>

#### Course Outcomes:

1. Discuss the anatomy of different systems in Vertebrates
2. Analyze the structural modifications in anatomy of different groups

#### Learning Outcomes:

- Describe the anatomy of different systems in Vertebrates
- Compare the structural modifications in anatomy of different groups

#### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural						
Metacognitive						

#### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

#### Modes of assessment

1. One internal examination (theory)
2. One internal examination (Lab)
3. Viva-voce/Group discussion/ Home assignments

#### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total Hours
1	<b>Integumentary System:</b> Structure, functions and derivatives of integument	8	1	-	9
2	<b>Skeletal System:</b> Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches	8	1	-	9
3	<b>Digestive System and Urinogenital System</b> Alimentary canal and associated glands, dentition Succession of kidney, Evolution of urinogenital ducts, Types of mammalian urinogenital system	8	1	-	9
4	<b>Respiratory System:</b> Skin, gills, lungs and air sacs; Accessory respiratory organs General plan of circulation, evolution of heart and aortic arches	8	1	-	9
5	<b>Nervous System and Sense Organ</b> Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals Classification of receptors Brief account of visual and auditory receptors in man	8	1	-	9
6	<b>Practicals:</b> Dissection of fish (carp) to study efferent and afferent branchial system(subject to permission) Study of placoid, cycloid and ctenoid scales through permanent slides /photographs. Study of Disarticulated skeleton of Frog, <i>Varanus</i> , Fowl, Rabbit. Study of Mammalian skulls: One herbivorous and one carnivorous animal Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)	-	-	15	15
	<b>TOTAL</b>	<b>40</b>	<b>5</b>	<b>15</b>	<b>60</b>

Where,

*L: Lectures*

*T: Tutorials*

*P: Practicals*

#### SUGGESTED READINGS:

- Comparative Anatomy of Vertebrates by RK Saxena
- Anatomy of the Vertebrates by George C Kent
- Modern Textbook of Zoology by RL Kotpal

### SEMESTER III

<b>Title of the Course</b>	:	<b>Comparative Anatomy of Vertebrates</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>MINOR</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>100 ( 60 END + 40 IA)</b>

#### COs:

1. Discuss the anatomy of different systems in Vertebrates
2. Analyze the structural modifications in anatomy of different groups

#### Learning Outcomes:

- Describe the anatomy of different systems in Vertebrates
- Compare the structural modifications in anatomy of different groups

#### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural						
Metacognitive						

#### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

#### Modes of internal assessment

- One internal examination (theory)
- One internal examination (Lab)
- Viva-voce/Group discussion /Home assignments

#### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total Hours
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1	<b>Integumentary System:</b> Structure, functions and derivatives of integument	8	1	-	9
2	<b>Skeletal System:</b> Overview of axial and appendicular skeleton, , Visceral arches	8	1	-	9
3	<b>Digestive System and Urinogenital System</b> Alimentary canal and associated glands, dentition Succession of kidney, Urinogenital ducts, Types of mammalian urinogenital system	8	1	-	9
4	<b>Respiratory System:</b> Skin, gills, lungs and air sacs; Accessory respiratory organs General plan of circulation, evolution of heart	8	1	-	9
5	<b>Nervous System and Sense Organ</b> Comparative account of brain Autonomic nervous system, Spinal cord, Brief account of visual and auditory receptors in man	8	1	-	9
6	<b>Practicals:</b> Dissection of fish (carp) to study efferent and afferent branchial system(subject to permission) Study of placoid, cycloid and ctenoid scales through permanent slides /photographs Study of Disarticulated skeleton of Frog, <i>Varanus</i> , Fowl,Rabbit Study of Mammalian skulls: One herbivorous and one carnivorous animal Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)	-	-	15	15
	<b>TOTAL</b>	<b>40</b>	<b>5</b>	<b>15</b>	<b>60</b>

*Where,*

*L: Lectures*

*T: Tutorials*

*P: Practicals*

**SUGGESTED READINGS:**

- Comparative Anatomy of Vertebrates by RK Saxena
- Anatomy of the Vertebrates by George C Kent
- Modern Textbook of Zoology by RL Kotpal

**SEMESTER III**

<b>Title of the Course</b>	:	<b>INSECT VECTORS AND DISEASES</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>GEC III</b>
<b>Total Credits</b>	:	<b>03</b>
<b>Distribution of Marks</b>	:	<b>75 (45 (End Sem) + 30 (In-Sem))</b>

**Course Outcomes:**

1. Analyze the concept of insects as vectors of diseases
2. Evaluate the general features of insects
3. Examine the role of different insects in transmission of diseases

**Learning Outcomes:**

- Explain the concept of insects as vectors of diseases
- Analyze insect features and their role in disease transmission

**Mapping of CO with Bloom Taxonomy**

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural						
Metacognitive						

**Mapping of Course outcomes to Programme outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce
- Group discussion/ Home assignments

**Attainment strategy:**

- Continuous evaluation through in and end semester examination
- Viva-voce examination
- Submission of Assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	<b>Introduction to insects:</b> General features of insects; Morphological features- Head, Eyes, Antenna, Mouthparts	6	1	-	7
2	Concept of Vectors: Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity	5	1	-	6
3	Insect as vectors: Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera	7	1	-	8
4	<b>Dipterans as important insect vectors</b> – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes Study of sand fly-borne diseases – Leishmaniasis, Phlebotomus fever; Control of Sand fly Study of house fly as important mechanical vector, Control of house fly	8	1	-	9
5	<b>Siphonaptera and Siphunculata as disease vectors:</b> Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas. Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever.	8	1	-	9
6	<b>Hemiptera as Disease vectors:</b> Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures	5	1	-	6
	<b>TOTAL</b>	<b>39</b>	<b>6</b>	<b>-</b>	<b>45</b>

Where,

*L: Lectures*

*T: Tutorials*

*P: Practicals*

**SUGGESTED READINGS:**



- Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK
- Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge, University Press, UK
- Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication.
- Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

### SEMESTER III

<b>Title of the Course</b>	:	<b>VEMICOMPOSTING</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>SEC III a</b>
<b>Total Credits</b>	:	<b>03</b>
<b>Distribution of Marks</b>	:	<b>75 (45 End + 30 IA)</b>

#### COs:

- 1) describe the biology of some important species of earth worms used in vermiculture
- 2) demonstrate skills on production of vermicompost.
- 3) analyze benefits and problems with vermiculture and vermicompost

#### Learning Outcome:

- 1) identify the earthworm species used in vermiculture
- 2) understand the benefit of vermiculture
- 3) display the skill of vermicompost production
- 4) interpret the problems associated with the vermicomposting technique

#### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual		CO1				
Procedural			CO2	CO3		
Metacognitive						

#### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

#### Modes of internal assessment:

1. One internal examination (Theory)
2. Practical exam and Viva-voce
3. Group discussion/ Home assignments

#### Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

	<b>CONTENTS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total</b>
<b>UNITS</b>					<b>Hours</b>
1	<p><b>Introduction to vermiculture</b>  Vermiculture - definition, meaning, history, economic importance, value in maintenance of soil structure, role as four r's of recycling (reduce, reuse, recycle and restore), Role in bio transformation of the residues generated by human activity and production of organic fertilizers, Useful species of earthworms, local and exotic species of earthworms</p>	7	-	-	7
2	<p><b>Biology of certain important earthworm native to NE India</b>  Taxonomy Anatomy, physiology and reproduction of Lumbricidae. Vital cycle: alimentation, fecundity, annual reproducer potential and limit factors (gases, diet, humidity, temperature, PH, light, and climatic factors).</p>	8	-	-	8
3	<p><b>Process of Vermicomposting</b>  Small scale earthworm farming for home gardens - earthworm compost for home gardens  Conventional commercial composting - earthworm composting larger scale (pit, brick and heap systems)  Earthworm farming, extraction (harvest), vermicomposting harvest and processing.  Vermiwash collection, composition and use.  Enemies of earthworms, sickness and worm's enemies; frequent problems – prevention and fixation.</p>	7	1	-	8
4	<p><b>Applications of vermiculture</b>  Benefits of vermicompost, Use of vermicompost in agriculture, Basic characteristics of earthworm suitable for vermicomposting, Problems in vermicomposting, vermicomposting of dairy waste.</p>	6	1	-	7
5	<p><b>Practical activities</b></p> <ol style="list-style-type: none"> <li>1. Key to identify different types of earthworms.</li> <li>2. Study of Life stages &amp; development of earthworms.</li> <li>3. Study of Vermiculture, Vermiwash &amp; Vermicompost equipments, devices.</li> <li>4. Preparation vermibeds, maintenance of</li> </ol>	-	-	15	15

	vermicompost & climatic conditions. 5. Study of verms diseases & enemies 6. Field trip- collection of native earthworms & their identification				
	TOTAL	<b>28</b>	<b>2</b>	<b>15</b>	<b>45</b>

### **SUGGESTED READINGS**

- Vermitechnology by A. Mary Violet Christy
- A textbook of Vermicompost by Keshav Singh
- The worm farmer's handbook by Rhonda Sherman
- Vermicomposting Principles, practice and benefits by Maximallian Schiller
- Vermiculture and Organic farming by TV Sathe
- Vermicompost production by Dr. S Rehan Ahmad
- Commercial vermiculture by Peter Bogdanov

### SEMESTER III

<b>Title of the Course</b>	:	<b>MEDICAL DIAGNOSTICS</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>SEC III b</b>
<b>Total Credits</b>	:	<b>03</b>
<b>Distribution of Marks</b>	:	<b>75 ( 45 End + 30 IA)</b>

#### COs

1. Analyze the concept of medical diagnostics
2. Compare the basic diagnostic tools and techniques.

Learning Outcomes:

- Understand the concept of medical diagnostics
- Distinguish between various diagnostic methods

#### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1		
Procedural				CO2		
Metacognitive						

#### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

#### Modes of internal assessment:

1. One internal examination –Theory and Practical
2. Viva-voce
3. Group discussion/ Home assignments

Attainment strategy:

- Continuous evaluation through in and end semester theory examination
- In and end semester practical examination
- Submission of practical file
- Viva-voce examination

UNITS	CONTENTS	L	T	P	Total
1	<b>Introduction to Medical Diagnostics:</b> Importance of medical diagnostics. Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.).	5	1	-	6
2	Urine Analysis: Physical characteristics; Abnormal constituents Tumours: Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, MRI and CT Scan (using photographs).	10	2	-	12
3	Non-infectious diseases: Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit Infectious diseases: Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis	10	2	-	12
4	Practicals:  1) Introduction to various tools involved in medical diagnosis 2) Determination of sugar in urine and blood 3) Determination of erythrocyte sedimentation rate 4) Study of ECG (PQRS) 5) Study of heart functioning 6) Whole blood count. 7) Urea estimation in urine.	-	-	15	15
	<b>TOTAL:</b>	25	5	15	45

**Where,                      L: Lectures                      T: Tutorials                      P: Practicals**

**SUGGESTED READINGS**

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

## SEMESTER IV

<b>Title of the Course</b>	:	<b>Biochemistry and Molecular Biology</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>CORE V</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>100 ( 60 End + 40 IA)</b>

### COs:

1. differentiate the biomolecules of living organisms, their interactions for perpetuation of life
2. analyze structure-function relationships of nucleic acids and protein
3. distinguish between replication, transcription and translation in prokaryotes and eukaryotes
4. interpret the gene expression mechanisms

### Learner Outcome:

- 1) identify the various biomolecules and understand their function
- 2) differentiate the cellular processes such as replication, transcription and translation
- 3) understand gene expression mechanism

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual			CO4	CO1, CO2, CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

1. Internal examination
2. Viva-voce/Group discussion/Home assignments

### Attainment of Cos:

1. Continuous evaluation through in and end semester examinations
2. Submission of assignments

<b>UNITS</b>	<b>CONTENTS</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>Total Hours</b>
1	Introduction to Biochemistry, scopes; chemical basis of life, functional groups; water as solvent, ionization of water, weak acids; pH, buffer solution; types of chemical bonds in biological systems and types of biomolecules (Macro and small molecules) and functions.	8	2	-	10
2	Proteins: Classification and functions of proteins. Amino acids, properties, and functions. Peptide bonds and peptide groups; structural organization of protein- primary, secondary, tertiary, and quaternary. The structural and functional relationship of protein- Ribonuclease-A, myoglobin, hemoglobin; protein denaturation and renaturation.	8	2	-	10
3	Carbohydrates: Sources, and biological functions; Classification- monosaccharide, disaccharide, and polysaccharide. Classes and structure of mono and disaccharides, glycosidic bond: Stereoisomerism, mutarotation, anomer, epimer etc.; glycoproteins and glycolipids.	8	2	-	10
4	Lipids: Structure, classification, and biological functions of lipids; storage and membrane lipids, lipoprotein. Fatty acids: classification; saturated, unsaturated, polyunsaturated; essential and non-essential fatty acids.	8	2	-	10



5	Nucleic acids: Types and functions of DNA, RNA; constituent monomers (nucleotides and nucleoside), DNA as genetic material, Structure of DNA and tRNA DNA replication: Chemistry of replication, DNA polymerases, synthesis of leading and lagging strands Prokaryotic transcription: RNA polymerase, promoters, sigma factors, initiation, elongation, and termination (Rho-dependent and independent), Eukaryotic transcription: types of RNA polymerases Translation: Translation in prokaryotes and eukaryotes: Ribosome, tRNA, amino-acyl tRNA synthetases, genetic code, translation-initiation, elongation, termination, and ribosomerecycling. Regulation of gene expression in prokaryotes: Transcriptional regulation in bacteria: regulation of lac and trp operons in bacteria	15	5	-	20
		57	13	-	60

#### SUGGESTED READING

- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson

## SEMESTER IV

<b>Title of the Course</b>	:	<b>Animal Physiology</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>CORE VI</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>100 ( 60 End + 40 IA)</b>

### COs:

1. Describe the different systems of vertebrates
2. Distinguish between the mechanisms of various physiological systems
3. Examine the body parameters based on the knowledge

### Learning outcomes:

- Compare the various physiological systems
- Analyze the mechanisms involved in the systems
- Apply the knowledge to correlate various parameters of the body

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural				CO3		
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/ Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
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1	<p><b>Digestive System, Urinogenital System and Excretory System</b></p> <p>Alimentary canal and associated glands, dentition 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.</p>	12	2	-	14
	<p>Succession of kidney, Evolution of urinogenital ducts, Structure of kidney and its functional unit; Mechanism of urine formation</p>				
2	<p><b>Respiratory System</b></p> <p>Brief account of gills, lungs, air sacs and swim bladder Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it.</p>	8	2	-	10
3	<p><b>Blood</b></p> <p>Components of blood and their functions; Structure and functions of haemoglobin Haemostasis: Blood clotting system, Kallikrein-Kininogen system, Complement system&amp; Fibrinolytic system, Haemopoiesis Blood groups: Rh factor, ABO and MN</p>	7	1	-	8
4	<p><b>Circulatory System</b></p> <p>Evolution of heart and aortic arches, Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses, Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram.</p>	8	2	-	10
5	<p><b>Reproductive system</b></p> <p>Histology of testis and ovary; comparative structure of male and female reproduction in human; physiology of male and female reproduction in human, Puberty, menstrual cycle. Methods of contraception in male and female, pregnancy and lactation</p>	7	1	-	8
		<b>52</b>	<b>8</b>	<b>-</b>	<b>60</b>

**Title of the Course** : Lab Course on C-V,VI,VII  
**Course Code** :  
**Nature of the Course** : **CORE VIII**  
**Total Credits** : **4**  
**Distribution of Marks** : **100 (60 END + 40 IA)**

**COs:**

1. Analyze biochemical solutions
2. Estimation of DNA
3. Examine the principles of gene interactions
4. Differentiate between various fossils, homologous and analogous organs
5. Distinguish between blood groups and analyze blood parameters

**Learning Outcome:**

- Compare biochemical solutions
- Analyze DNA
- Discuss the principles of gene interactions
- Compare between various fossils, homologous and analogous organs
- Understand the blood groups and test blood parameters

**Mapping of CO with Bloom Taxonomy**

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual						
Procedural				CO1, CO3, CO4	CO2, CO5	
Metacognitive						

**Mapping of Course outcomes to Programme outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination
- Viva-voce/Group discussion/Home assignments

**Attainment of Cos:**

- Continuous evaluation through in and end semester examinations
- Submission of assignments
- Submission of practical record book

UNIT	CONTENT	Practical
1	<ol style="list-style-type: none"> <li>1. Preparation of different biochemical solutions, dilutions, preparation of buffer solutions etc.</li> <li>2. Qualitative tests of carbohydrates, proteins and lipids, ascorbic acid, free phosphate</li> <li>3. DNA extraction by</li> </ol>	15
	phenol chloroform method and estimation by Diphenylamine method.	
2	<ol style="list-style-type: none"> <li>1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.</li> <li>2. Project on Epigenetic, Eugenics, Euthenics and Euphenics.</li> <li>3. Study of Human Karyotypes (normal and abnormal)</li> </ol>	15
3	<ol style="list-style-type: none"> <li>1. Study of fossils (types, forms and dating) from models/pictures</li> <li>2. Study of homology, analogy and homoplasy from suitable specimens</li> </ol>	15
4	<ol style="list-style-type: none"> <li>1. Determination of Blood groups, RBC Count and WBC count</li> <li>2. Study permanent slides of Ovary and Testes.</li> </ol>	15
	TOTAL	60

## SEMESTER IV

**Title of the Course : Fundamentals of Animal Physiology**

**Course Code :**

**Nature of the Course : Minor**

**Total Credits : 04**

**Distribution of Marks : 100 (60 End + 40 IA)**

### COs:

1. Describe the different systems of vertebrates
2. Distinguish between the mechanisms of various physiological systems
3. Examine the body parameters based on the knowledge

### Learning outcomes:

- Compare the various physiological systems
- Analyze the mechanisms involved in the systems
- Apply the knowledge to correlate various parameters of the body

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2		
Procedural				CO3		
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	<p><b>Digestive System, Urinogenital System and Excretory System</b></p> <p>Alimentary canal and associated glands, dentition 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. Succession of kidney, Evolution of urinogenital ducts, Structure of kidney and its functional unit; Mechanism of urine formation</p>	12	2	-	14
2	<p><b>Respiratory System</b></p> <p>Brief account of gills, lungs, air sacs and swim bladder Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it.</p>	8	2	-	10
3	<p><b>Blood</b></p> <p>Components of blood and their functions; Structure and functions of haemoglobin Haemostasis: Blood clotting system, Kallikrein-Kininogen system, Complement system&amp; Fibrinolytic system, Haemopoiesis Blood groups: Rh factor, ABO and MN</p>	7	1	-	8
4	<p><b>Circulatory System</b></p> <p>Evolution of heart and aortic arches, Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses, Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram.</p>	8	2	-	10
5	<p><b>Reproductive system</b></p> <p>Histology of testis and ovary; comparative structure of male and female reproduction in human; physiology of male and female reproduction in human, Puberty, menstrual cycle. Methods of contraception in male and female, pregnancy and lactation</p>	7	1	-	8
		<b>52</b>	<b>8</b>	<b>-</b>	<b>60</b>

## SEMESTER IV

**Title of the Course** : **Genetics and Evolutionary Biology**  
**Course Code** :  
**Nature of the Course** : **CORE VII**  
**Total Credits** : **04**  
**Distribution of Marks** : **40 (IA) + 60 (END) =100**

### COs:

- 1) Interpret the basic patterns of inheritance
- 2) Evaluate genetic disorders and mutations
- 3) Relate evolutionary forces leading to the variations and diversification of species
- 4) Examine evidences ranging from fossil records to molecular data and to establish phylogenetic relationships of species.

### Learning Outcome:

- 1) Understand the concept of inheritance
- 2) Analyze mutations and genetic disorders
- 3) Examine forces of evolution
- 4) Interpret evidences of evolution

### Mapping of CO with Bloom's taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1		
Procedural				CO3,CO4	CO2	
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/Home assignments

### Attainment of Cos:

- Continuous evaluation through in and end semester examinations



- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	<p><b>Mendelian Genetics and its Extensions</b> Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, penetrance and expressivity, Epistasis, Phenocopy, Pleiotropy, Polygenic Inheritance, Sex-linked, Sex-influenced, and Sex-limited characters inheritance and sex determination.</p>	9	1	-	10
2	<p><b>Linkage, Crossing Over and Chromosome Mapping and sex determination</b> Linkage and crossing over, Cytological basis of crossing over, Recombination frequency as a measure of linkage intensity, two-factor and three-factor crosses, Linkage map, Coefficient of Coincidence and Interference, Gene mapping Basis of sex determination: Genetic and environmental; Sex determination human; Mechanism of dosage compensation. Comparison of nuclear and extranuclear inheritance, maternal effects with examples.</p>	9	1	-	10
3	<p><b>Chromosomal and gene mutation and Extra-chromosomal Inheritance</b> Types of gene mutations, Mutagens: Physical and chemical, molecular basis of spontaneous and induced mutations, Chromosomal aberrations: Structural Variations in chromosomes, Aneuploidy &amp; Polyploidy. Transposons and its significance</p>	9	1	-	10
4	<p><b>Historical Review of Evolutionary Concepts and Beginning of Life and Evidences of Evolution</b> Lamarckism, Darwinism, Neo-Darwinism, Chemogeny, RNA world, biogeny, endo-symbiotic theory, Palaeontological: geological time scale; phylogeny of horse; Molecular: neutral theory of evolution, example of globin gene family, rRNA/Cyt c.</p>	9	1	-	10

5	<b>Process and Product of Evolution</b> Variations: Heritable variations and their role in evolution Qualitative studies: Natural selection, types of natural selection, artificial selection, kin selection, adaptive resemblances, sexual selection, frequency dependent selection. Quantitative studies: Natural selection. Hardy-Weinberg law, genetic drift (founder's effect, bottleneck phenomenon), migration and mutation (genetic load), Speciation: micro-evolutionary changes, species concept, isolating mechanisms. Mass extinctions (events, causes and effects), Primate characteristics and phylogeny from Dryopithecus leading to Homo sapiens, molecular evidences of modern human.	18	2	-	20
		59	6	-	60

### Suggestive readings

1. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons In.
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cumming
3. Pierce, B. A. (2012). Genetics-A Conceptual Approach. IV Edition. W. H. Freeman and Company
4. Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, Sean B. Carroll (2007). Introduction to Genetic Analysis. 9th Edition. W H Freeman.
5. Roberts, A. (2018) Evolution: the human story, Dorling, Kindersley Ltd.
6. Hall, B.K. and Hallgrimson, B. (2013). Evolution. V Edition, Jones and Barlett Publishers.
7. Campbell, N.A. and Reece J.B. (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
8. Barton N.H., Briggs D.E.G., Eisen J.A., Goldstein D.B. and Patel N.H., (2007) 1st Ed. Evolution, Cold Spring Harbor Laboratory Press.

## SEMESTER V

<b>Title of the Course</b>	:	<b>DEVELOPMENTAL BIOLOGY</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>CORE IX</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>40 (IA) + 60 (END) = 100</b>

### COs:

1. Examine the basic principles and concepts the developmental processes from a single cell system to a multi-cellular system
2. Distinguish the embryonic and post embryonic developmental processes
3. Analyze the development of a single fertilized egg to mature into a fully developed complex organism

### Learning Outcome:

- Describe developmental processes of biological system
- Compare various embryonic developmental processes

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1,CO2,CO3		
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.1
CO2	3	2	2	2	2	2	2	2.1
CO3	3	2	3	1	1	2	2	2.0
CO4	3	3	2	2	2	1	1	2.0
AVERAGE	3.0	2.2	2.2	1.7	1.7	1.7	1.7	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- One Theory Internal examination
- One Practical Internal examination
- Viva-voce/Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

- Submission of practical record book

UNITS	CONTENTS	L	T	P	Total Hours
1	<b>Introduction</b> Historical perspectives and basic concepts: Phases of development, Pattern formation, Differentiation and growth, Cytoplasmic determinants and asymmetric cell division	10	1	-	11
2	<b>Early Embryonic Development</b> Gametogenesis: oogenesis, spermatogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal), Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps; Gastrulation in frog and chick, Embryonic induction and organizers.	10	1	-	11
3	<b>Late Embryonic Development</b> Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, structure, types, and functions of placenta.	10	1	-	11
4	<b>Post Embryonic Development</b> Metamorphosis and its hormonal regulation in amphibians and insects; Regeneration: brief concept of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: concepts and theories. Teratogenesis: Teratogenic agents and their effects on embryonic development.	10	2	-	12
5	Lab Course 1. Study of whole mounts and sections of developmental stages of Amphibia through permanent slides: Cleavage stages, blastula, gastrula, neurula 2. Study of whole mounts of developmental stages of chick through permanent slides (Hamburger and Hamilton Stages): Stage 3 (Intermediate Streak)-13 hours, Stage 4 (Definitive Streak)-18 hours, Stage 5 (Head Process)-21 hours, Stage 7- 24 hours, Stage 8-28 hours, Stage 10-33 hours, Stage 11-40	-	-	15	15

	hours, Stage 13-48 hours, Stage 19- 72 hours and Stage 24-96 hours of incubation				
		<b>45</b>	<b>5</b>	<b>15</b>	<b>60</b>

### **Suggestive readings**

1. Slack, J.M.W. (2013) Essential Developmental Biology. III Edition, Wiley- Blackwell.
2. Gilbert, S. F. (2010) Developmental Biology. IX Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA
3. Carlson, B.M. (2007) Foundations of Embryology. VI Edition, Tata McGraw-Hill Publishers.
4. Balinsky B. I. and Fabian B. C. (2006). An Introduction to Embryology. VIII Edition, International Thompson Computer Press.

**SEMESTER V**

<b>Nature of the Course</b>	:	<b>CORE X</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>100 (End Sem: 80 + In-Sem: 20)</b>

**Course outcomes:**

1. Analyze behaviour patterns to the brain, genes, and hormones, as well as the surrounding ecological and social environments
2. Interpret the concept of chronobiology.
3. Evaluate the phenomena of seasonal migration and hibernation

**Learning Outcomes:**

- Distinguish various behaviour patterns of animals
- Understand chronobiology concept
- Analyze different behaviours such as migration and hibernation

**Mapping of CO with Bloom Taxonomy**

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1	CO2	
Procedural					CO3	
Metacognitive						

**Mapping of Course outcomes to Programme outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

**Modes of internal assessment**

- Internal examination (Theory and practical)
- Viva-voce/Group discussion/Home assignments

**Attainment of COs:**

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	Introduction to Animal Behaviour Origin and history of Ethology; Brief profiles of Karl Von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Proximate and ultimate causes of behaviour	10	1	-	11
2	Patterns of Behaviour and Communication Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, Habituation, Imprinting. Importance of communication; Role of Chemical, Tactile, Auditory, Visual stimuli in communication.	10	1	-	11
3	Social and Sexual Behaviour Concept of Society, Social insect, bee communication and the senses; Altruism, Hamilton Rule, Sexual Behaviour: Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.	10	1	-	11
4	Introduction to Chronobiology Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks. Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms; Photoperiod and insects. Relevance of biological clocks; Chronomedicine, Chronotherapy.	10	2	-	12
5	Lab Course 1. To study nests and nesting behaviour of the birds and social insects. 2. To study the taxis behaviour in insect larvae. 3. To study colouration pattern in fishes. 4. To study habituation in mosquito larvae 5. Observation of animal architects: Termites, wasp, Harvester ant and any bird.	-	-	15	15
		45	5	15	60

### Suggestive Readings:

- Alcock, J. (2013) Animal Behaviour, Xth Edition, Sinauer Associates Inc., USA.
- Manning, A. and Dawkins, M. S, (2012) An Introduction to Animal Behaviour, VIth Edition, Cambridge University Press, UK
- McFarland, D. (1985) Animal Behaviour, Pitman Publishing Limited, London, UK
- Binkley, S. (2020). Biological clocks: Your owner's manual. CRC Press.
- Vinod Kumar (2017): Biological Timekeeping: Clocks, Rhythms and Behaviour.

## SEMESTER V

**Title of the Course : Animal Biotechnology and techniques in Biology**

**Course Code :**

**Nature of the Course: CORE XI**

**Total Credits 04**

**Distribution of Marks: 100 (60 End + 40 IA)**

### COs:

- Describe the principle, practices and application of biotechnology.
- Explain the basic concept of genetic engineering.
- Improve the students in the field of biotechnology for application in every field of science like engineering, research, commercialization and academics.

### Learning Outcomes:

- Discuss the principle, practices and application of biotechnology.
- Discuss the basic concept of genetic engineering.
- Make the students aware about the field of biotechnology for application in every field of science like engineering, research, commercialization and academics.

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2	CO3	
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments



## Section A

### **Unit 1: Recombinant DNA technology**

**(Lecture 8)**

Introduction to biotechnology; Restriction Endonucleases (History, Types I-IV, biological role and application); Cloning Vectors; types

### **Unit-2: Gene Cloning**

**(Lecture: 8)**

Recombinant DNA technology, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning, DNA libraries, cDNA libraries, colony hybridization; Somatic cell nuclear transfer.

### **Unit-3: Techniques in Biology**

**(Lecture 15)**

Working Principle and uses of Optical Microscopy (Resolving Power, brightfield, darkfield), electron microscopy. Centrifugation, Spectrophotometry-UV-Vis. Precautions. Blotting techniques- Southern, Northern, Western. DNA sequencing techniques.

### **Unit-4: Animal Cell culture**

**(Lecture 6)**

Concept of cell culture, media, applications of animal cell culture, precautions.

### **Unit-5: Applications of Biotechnology**

**(Lecture: 8)**

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

## **Section B**

**(15 lectures)**

### **Lab Course**

1. Demonstration of spectrophotometer, microscopes, autoclave, microscope, colourimeter, pH-meter, electrophoresis, and centrifuge.  
etc.
2. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
3. Restriction digestion and gel electrophoresis of plasmid DNA.
4. Demonstration of animal cell culture technique through photographs/animation
5. Separation of amino acids by paper chromatography

## SEMESTER V

**Title of the Course : Animal Biotechnology and techniques in Biology- Minor**  
**Course Code :**  
**Nature of the Course: MINOR**  
**Total Credits 04**  
**Distribution of Marks: 100 (60 End + 40 IA)**

### COs:

- Describe the principle, practices and application of biotechnology.
- Explain the basic concept of genetic engineering.
- Improve the students in the field of biotechnology for application in every field of science like engineering, research, commercialization and academics.

### Learning Outcomes:

- Discuss the principle, practices and application of biotechnology.
- Discuss the basic concept of genetic engineering.
- Make the students aware about the field of biotechnology for application in every field of science like engineering, research, commercialization and academics.

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1, CO2	CO3	
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

**Unit 1: Recombinant DNA technology****(Lecture 8)**

Introduction to biotechnology; Restriction Endonucleases (History, Types I-IV, biological role and application); Cloning Vectors; types

**Unit-2: Gene Cloning****(Lecture 8)**

Recombinant DNA technology, Bacterial Transformation and selection of recombinant clones, PCR mediated gene cloning, DNA libraries, cDNA libraries, colony hybridization; Somatic cell nuclear transfer.

**Unit-3: Techniques in Biology****(Lecture 15)**

Working Principle and uses of Optical Microscopy (Resolving Power, brightfield, darkfield), electron microscopy. Centrifugation, Spectrophotometry-UV-Vis. Precautions. Blotting techniques- Southern, Northern, Western. DNA sequencing techniques.

**Unit-4: Animal Cell culture****(Lecture 6)**

Concept of cell culture, media, applications of animal cell culture, precautions.

**Unit-5: Applications of Biotechnology****(Lecture 8)**

Pest resistant (Bt-cotton); herbicide resistant plants (RoundUp Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase); Genetically Engineered Products–Human Growth Hormone; Humulin; Biosafety concerns.

Section B

(15 lectures)

Unit 6: Lab Course

1. Demonstration of spectrophotometer, microscopes, autoclave, microscope, colourimeter, pH-meter, electrophoresis, and centrifuge.  
etc.
2. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
3. Restriction digestion and gel electrophoresis of plasmid DNA.
4. Demonstration of animal cell culture technique through photographs/animation
5. Separation of amino acids by paper chromatography

## SEMESTER VI

**Title of the Course : Animal Physiology : Controlling and Co-ordinating Physiology**

**Course Code :**

**Nature of the Course : CORE XII**

**Total Credits : 04**

**Distribution of Marks : 100 ( 60 End + 40 IA)**

### COs:

1. Examine the internal working of organs and organ systems.
2. Evaluate the functioning of various organ systems such as muscular, nervous, and blood in vertebrates.
3. Explain endocrine system and its role in integration.

### Learning Outcomes:

- Discuss the working of organ and organ systems
- Analyze the functioning of the various systems
- Describe the role of endocrine system

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1	CO2, CO3	
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Home assignments

### Attainment of Cos:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	Tissues: Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue	10	1	-	11
2	Bone and cartilage: Structure and types of bones and cartilages, Ossification, bone growth and Resorption	10	1	-	11
3	Muscle 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	10	1	-	11
4	Nervous system Types of nerves and nervous system, Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc	10	2	-	12
5	<b>Endocrine System</b> Comparative account of endocrine glands in vertebrates, Histology of pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones;; Mode of hormone action, Hypothalamus and principal nuclei involved in neuroendocrine control of endocrine system, feedback mechanism.	15	3	-	15
		<b>45</b>	<b>8</b>	<b>-</b>	<b>60</b>

### SUGGESTED READINGS

- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.

- Tortora, G.J. - and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander 's Human Physiology, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.

## SEMESTER VI

<b>Title of the Course</b>	:	<b>Animal Ecology and Wildlife Management</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>CORE XIII</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>100 ( 60 END + 40 IA)</b>

### COs:

1. Describe an understanding of ecological principles and processes.
2. Evaluation of the essential elements, concepts and skills related to wildlife conservation and management.

### Learning Outcomes:

- Discuss ecological principles and processes.
- Examine the essential elements, concepts and skills related to wildlife conservation and management.

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1	CO2	
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

1. Introduction to ecology **(Lectures 10)**  
Definitions; ecology, habitat, Ecozone, biosphere, ecosystems, resistance and resilience, autecology, synecology, biome, Liebig's law of minimum, Shelford's law of tolerance, ecotype, ecological niche.
2. Ecology of populations and community **(Lectures 10)**  
Concept of population, metapopulation; characteristics of population; density, dispersion, natality, mortality, life table, survivorship curve, age structure, population growth, limits to population growth, population interactions; parasitism, mutualism, commensalism, symbiosis, Community characteristics: species richness, dominance, diversity, abundance.
3. Ecosystem ecology **(Lectures 10)**  
Concept of ecosystem; structure and function of ecosystem; producer, consumers, decomposers, energy flow, food chain, food web and ecological pyramids.
4. Introduction to wild life **(Lectures 10)**  
Values of wild life; threats, conservation ethics, importance of conservation, world conservation strategies.
5. Evaluation and management of wild life **(Lectures 10)**  
Habitat analysis; physical parameters; topography, geology, soil and water; biological parameters; food, cover, forage, browse and cover estimation, basics of remote sensing and GIS, HIS, CDI, SDI.
6. Protected sites and management **(Lectures 10)**  
Important features of protected areas in India  
National parks and sanctuaries, community reserves and Tiger Reserve.  
Setting back succession, grazing, logging; mechanical treatment; advancing the successional process. Preservation of general; genetic diversity; ecological restoration.

### **Suggested Readings:**

- Ecology and Environment: P.D. Sharma, Rastogi Publications.
- Ecology (Amerind). By Odum • Fundamentals of ecology (W. B. Saunders). by Odum
- Ecology (W. H. Freeman & Co., New York). by R. E. Ricklefs & G. Miller.
- Environmental Science (W. B. Saunders) by Turk & Turk
- Ecology, individuals, populations and communities (Blackwell Science Oxford). By M. Begon, J. L. Harper & C. R. Townsend.
- The book of Indian animals (Oxford Univ. Press). By S. H. Prater
- Essentials of Biogeography, by H.S. Mathur, Pointer Publ. Jaipur.
- Fundamental of Ecology; SK Agarwal. Ashis Publication House, New Delhi.
- Biodiversity (Academic Press). By E. O. Wilson.



## SEMESTER VI

<b>Title of the Course</b>	:	<b>Bioinformatics and Biostatistics</b>
<b>Course Code</b>	:	
<b>Nature of the Course</b>	:	<b>CORE XIV</b>
<b>Total Credits</b>	:	<b>04</b>
<b>Distribution of Marks</b>	:	<b>100 (60 END +40 IN)</b>

### COs:

1. Analyze computational tools and databases that facilitate investigation of molecular biology and evolution-related concepts
2. Evaluate computational approach for critical analysis and interpret the results of their study.
3. Examine the fundamental concepts of biostatistics.
4. Apply the various statistical methods and software tools for understanding data analysis in biological sciences.

### Learning Outcomes:

1. Compare computational tools and databases that facilitate investigation of molecular biology and evolution-related concepts
2. Analyze computational approach for critical analysis and interpret the results of their study.
3. Understand the fundamental concepts of biostatistics.
4. Apply the various statistical methods and software tools for understanding data analysis in biological sciences.

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual			CO4	CO1,CO3	CO2	
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

**Unit 1: Introduction to Bioinformatics: (Lectures 8)**

Introduction, Biological Databases, Classification of Biological Databases, Biological Database Retrieval System.

**Unit 2: Biological Sequence Databases (Lectures 12)**

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database, Entrez, Sequence Submission to NCBI-GenBank, Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-ENA): Introduction, Sequence Retrieval, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Protein Information Resource (PIR), UniprotKB: Swiss-Prot, TrEMBL: Introduction and Salient Features.

**UNIT-3: Sequence Alignments & Molecular Phylogeny (Lectures 10)**

Introduction, Concept of Alignment, Global and Local Alignments, Pairwise Sequence Alignment (PSA), Multiple Sequence Alignment (MSA), Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM), Basic Local Alignment Search Tool (BLAST), Methods of Phylogeny, Consistency of Molecular Phylogenetic Prediction.

**UNIT 4- Introduction to Biostatistics and Statistical Data (Lectures 10)**

Concept of statistics and its Applications in biological sciences, Sampling methods; Primary and secondary data; Qualitative and quantitative data; Discrete and continuous data

**UNIT- 5: Descriptive Statistics and Probability (Lectures 10)**

Statistical population and samples, Measures of Central tendency and Dispersion - Mean, Median and Mode, Variance, Standard Deviation and Standard Error; Coefficient of Variance. Normal, Binomial Skewness and Kurtosis.

**UNIT- 6: Statistical tests: (Lectures 10)**

Null and Alternative hypotheses, t Tests, Correlation Coefficient, Confidence Intervals and Confidence levels

## SEMESTER VI

**Title of the Course** : Lab Course on C-XII,XIII,XIV

**Course Code** :

**Nature of the Course** : CORE-XV

**Total Credits** 4

**Distribution of Marks: 100 (60 END + 40 IA)**

### COs:

1. Distinguish between haemin crystals of different species
2. Evaluate muscle twitch and reflex action
3. Examine sections of neurons and glands
4. Differentiate between various fauna
5. Critically Analyze ecosystem parameters and different behaviours in an ecosystem

### Learning Outcome:

- Compare haemin crystals of different species
- Analyze muscle twitch and reflex action
- Discuss various neuron structure and glands
- Compare between different fauna
- Understand the components of an ecosystem

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual						
Procedural				CO1, CO3, CO4	CO2, CO5	
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Group discussion/Home assignments

### Attainment of Cos:

- Continuous evaluation through in and end semester examinations

- Submission of assignments
- Submission of practical record book

UNIT	CONTENT	Practical Lectures
1	<ol style="list-style-type: none"> <li>1. Preparation of haemin and haemochromogen crystals</li> <li>2. Recording of simple muscle twitch with electrical stimulation (or Virtual)</li> <li>3. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)</li> <li>4. Examination of sections of mammalian nerves, different types of muscles.</li> <li>5. Study of permanent slides of Bone, Cartilage, Tissues, Neurons, Pituitary, Pancreas, Adrenal, Thyroid, Hypothalamus and Parathyroid</li> <li>6. Identification of mammalian fauna, avian fauna, herpeto-fauna, fishal fauna</li> </ol>	20

2	<ol style="list-style-type: none"> <li>1. Demonstration of basic equipment needed in wild life studies by pictures.</li> <li>2. 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).</li> <li>3. Study on Symbiosis in (Termite and Trychonympha, hermit crab and sea anemone)-virtual.</li> <li>4. Study of Camouflage on leaf insect, chameleon.</li> <li>5. Observation of animalarchitects: Termites, wasp, Harvester ant and any bird.</li> <li>6. Breeding and parental care in Amphibia/Fish, Rehabilitation of injured animals</li> </ol>	20
3	<ol style="list-style-type: none"> <li>1. To compute Coefficient of Variance from data collected and measure variability.</li> <li>2. To collect data on different parameters (e.g. height/weight) of animal/plant samples and test for significance, difference between mean, mode and median.</li> <li>3. Retrieval of DNA, RNA, protein sequences and structures from the biological databases and to create various datasets.</li> <li>4. Perform pairwise and multiplesequence alignments from the generated datasets in Experiment 1, using online/offline tool.</li> </ol>	20
	TOTAL	60

SEMESTER VI

**Title of the Course : Animal Physiology : Controlling and Co-ordinating Physiology -Minor**

**Course Code :**

**Nature of the Course : MINOR**

**Total Credits : 04**

**Distribution of Marks : 100 ( 60 End + 40 IA)**

**COs:**

1. Examine the internal working of organs and organ systems.
2. Evaluate the functioning of various organ systems such as muscular, nervous, and blood in vertebrates.
3. Explain endocrine system and its role in integration.

Learning Outcomes:

- Discuss the working of organ and organ systems
- Analyze the functioning of the various systems
- Describe the role of endocrine system

### Mapping of CO with Bloom Taxonomy

Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual						
Conceptual				CO1	CO2, CO3	
Procedural						
Metacognitive						

### Mapping of Course outcomes to Programme outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	AVERAGE
CO1	3	2	2	2	2	2	2	2.14
CO2	3	2	2	2	2	2	2	2.14
CO3	3	2	3	1	1	2	2	2.0
AVERAGE	3	2	2.3	1.7	1.7	2	2	

3 for highest correlation, 2 for moderate correlation, and 1 for lowest correlation

### Modes of internal assessment

- Internal examination
- Viva-voce/Home assignments

### Attainment of COs:

- Continuous evaluation through in and end semester examinations
- Submission of assignments

UNITS	CONTENTS	L	T	P	Total Hours
1	Tissues: Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue	10	1	-	11
2	Bone and cartilage: Structure and types of bones and cartilages, Ossification, bone growth and Resorption	10	1	-	11

3	Muscle 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	10	1	-	11
4	Nervous system Types of nerves and nervous system, Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc	10	2	-	12
5	<b>Endocrine System</b> Comparative account of endocrine glands in vertebrates, Histology of pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones;; Mode of hormone action, Hypothalamus and principal nuclei involved in neuroendocrine control of endocrine system, feedback mechanism.	15	3	-	15
		45	8	-	60

### SUGGESTED READINGS

- Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.
- Tortora, G.J. - and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) Vander 's Human Physiology, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.