



**CBCS SYLLABUS**  
**FOR**  
**THREE YEARS UNDER-GRADUATE**  
**COURSE IN**  
**Zoology (HONOURS)**  
**(With effect from the session 2022-2023)**



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# CONTENTS

SL No.	Subject Matter	Page No.
1.	Introduction	3
2.	Scheme for CBCS Curriculum	4
	2.1 Credit Distribution across Courses	4
	2.2 Scheme for CBCS Curriculum in Zoology (Honours)	5 - 6
	2.3 Choices of Skill Enhancement Courses	6
	2.4 Choices for Discipline Specific Electives	6
	2.5 Choices for Generic Elective Courses	6
	2.6 Question Pattern	7
	2.7 Odd Semester ID	7
	2.8 Even Semester ID	8
	2.9 Summary Scheme for CBCS Curriculum	9
	2.10 Programme Outcome (PO)	10
	2.11 Programme Specific Outcomes (PSO)	11
3.	Core Courses (Zoology Honours CC1 to 14)	12 – 40
4.	Discipline Specific Elective Courses (DSE1 to8)	41 -50
5.	Skill Enhancement Courses (SEC1 to4)	51 -53
6.	Generic Elective Courses (GE1 to 4)	54 -62

## Introduction

The syllabus for Zoology at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus of UGC. While framing the syllabus as per the UGC guideline, the topics have been kept as generic as possible in order to provide enough freedom to the individual Universities to detail out their own syllabus as per their own infrastructure, expertise and strength.

The main objective of framing this new syllabus is to give the students a holistic understanding of the subject giving substantial weightage to both the core content and techniques used in Zoology.

Keeping in mind and in tune with the changing nature of the subject, adequate emphasis has been given on new techniques and understanding of the subject.

The syllabus has also been framed in such a way that the basic skills of subject are taught to the students, and everyone might not need to go for higher studies and the scope of securing a job after graduation will increase.

There is wide deviation in the infrastructure, be it physical or in human resource, in the form of teachers' expertise and ability and aspiration of the students. Hence, University is free to choose the Electives as per their infrastructural strengths and offer at least 6 to 7 electives

While the syllabus is in compliance with UGC model curriculum, it is necessary that Zoology students should learn "Immunology" as one of the core courses rather than as elective while. Also, an important elective on "Microbiology" has been added.

Project Work may be introduced instead of the 4th Elective with a credit of 6 split into 2+4, where 2 credits will be for continuous evaluation and 4 credits reserved for the merit of the dissertation.



## 2. Scheme for CBCS Curriculum

### 2.1 Credit Distribution across Courses

Course Type	Total Papers	Credits	
		Theory +Practical	Theory*
Core Courses	14	14*4=56 14*2 =28	14*5 =70 14*1=14
Discipline Specific Electives	4	4*4=16 4*2=8	4*5=20 4*1=4
Generic Electives	4	4*4=16 4*2=8	4*5=20 4*1=4
Ability Enhancement Language Courses	2	2*2=4	2*2=4
Skill Enhancement Courses	2	2*2=4	2*2=4
<b>Total</b>	<b>26</b>	<b>140</b>	<b>140</b>

\*Tutorials of 1 Credit will be conducted in case there is no practical component

### 2.2 Scheme for CBCS Curriculum in Zoology (Honours)

#### SEMESTER –I

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UG/ZOOH / 101/C-1	CT-1: Non-chordates I CP-1: Non-chordates I Lab	4 2	10	25 15	50			
UG/ZOOH / 102/C-2	CT-2: Perspectives In Ecology CP-2: Perspectives In Ecology Lab	4 2	10	25 15	50			
UG/ZOO/ 103/GE-1	GE T : Animal Diversity GE P: Animal Diversity Lab	4 2	10	25 15	50			
UG/104/ AECC-1	Environmental Studies	4	10	40	50			
<b>Total in Semester - I</b>		<b>22</b>	<b>40</b>	<b>160</b>	<b>200</b>			

**SEMESTER –II**

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UG/ZOO H/ 201/C-3	CT-3: Non-chordates II CP-3: Non-chordates II Lab	4	10	25	50			
		2		15				
UG/ZOO H 202/C-4	CT-4: Cell-Biology CP-4: Cell-Biology Lab	4	10	25	50			
		2		15				
UG/ZOO 203/GE-2	GET : Aquatic Biology GEP: Aquatic Biology Lab	4	10	25	50			
		2		15				
UG/204/ AECC-2	English/Hind/MIL	2	10	40	50			
<b>Total in Semester - II</b>		<b>20</b>	<b>40</b>	<b>160</b>	<b>200</b>			

**SEMESTER –III**

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UG/ZOO H 301/C-5	CT-5: Diversity of Chordata CP-5: Diversity of Chordata Lab	4	10	25	50			
		2		15				
UG/ZOO H/ 302/ C-6	CT-6: Animal Physiology: Controlling and Co-ordinating systems CP-6: Animal Physiology: Controlling and Co-ordinating systems Lab	4	10	25	50			
		2		15				
UG/ZOO H/303/C-7	CT-7: Fundamental of Biochemistry CP-7: Fundamental of Biochemistry Lab	4	10	25	50			
		2		15				
UG/ZOO/ 304/GE-3	GET : Environment and Public Health GEP : Environment and Public Health Lab	4	10	25	50			
		2		15				
UG/ZOOH/ 305/SEC-1	SECT: Apiculture	2	10	40	50			
<b>Total in Semester - III</b>		<b>26</b>	<b>50</b>	<b>200</b>	<b>250</b>			

**SEMESTER –IV**

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UG/ZOOH /401/C-8	CT-8: Comparative Anatomy of Vertebrates CP-8: Comparative Anatomy of Vertebrates Lab	4	10	25	50			
		2		15				
UG/ZOOH /402/C-9	CT-9: Animal Physiology: Life Sustaining System CP-9: Animal Physiology: Life Sustaining System Lab	4	10	25	50			
		2		15				
UG/ZOOH /403/C-10	CT-10: Immunology CP-10: Immunology Lab	4	10	25	50			
		2		15				
UG/ZOO/ 404/GE-4	GET : Insect Vectors and Diseases GEP : Insect Vectors and Diseases Lab	4	10	25	50			
		2		15				
UG/ZOOH/ 405/SEC-2	SECT: Sericulture Or Aquarium Fish keeping	2	10	40	50			
<b>Total in Semester – IV</b>		<b>26</b>	<b>50</b>	<b>200</b>	<b>250</b>			

**SEMESTER –V**

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total			
UG/ZOOH / 501/C-11	CT-11: Molecular Biology CP-11: Molecular Biology Lab	4 2	10	25 15	50			
UG/ZOOH / 502/C-12	CT-12: Principles of Genetics CP-12: Principles of Genetics Lab	4 2	10	25 15	50			
UG/ZOOH / 503/DSE-1	DSET: Animal Behavior & Chronobiology DSEP: Animal Behavior & Chronobiology Lab	4 2	10	25 15	50			
UG/ZOOH / 504/DSE-2	DSET: Biology of Insecta DSEP: Biology of Insecta Lab	4 2	10	25 15	50			
<b>Total in Semester – V</b>		<b>24</b>	<b>40</b>	<b>160</b>	<b>200</b>			

**SEMESTER –VI**

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UG/ZOOH/ 601/C-13	CT-13: Developmental Biology CP-13: Developmental Biology Lab	4 2	10	25 15	50			
UG/SC/ 602/C-14	CT-14: Evolutionary Biology CP-14: Evolutionary Biology Lab	4 2	10	25 15	50			
UG/ZOOH/ 603/DSE-3	DSET: Fish & Fisheries DSEP: Fish & Fisheries Lab Or DSET: Parasitology DSEP: Parasitology Lab	4 2	10	25 15	50			
UG/ZOOH/ 604/DSE-4	DSET: Endocrinology DSEP: Endocrinology Lab	4 2	10	25 15	50			
<b>Total in Semester – VI</b>		<b>24</b>	<b>40</b>	<b>160</b>	<b>200</b>			

SC = Subject Code, C= Core Course, AECC= Ability Enhancement Compulsory Course, SEC= Skill Enhancement Course, GE= Generic Elective, DSE= Discipline Specific Elective  
IA= Internal Assessment, ESE= End-Semester Examination, Lec.=Lecture, Tu.= Tutorial, and Pr.=Practical

**Scheme for CBCS Curriculum in Zoology (Honours)**

Semester	Course Name	Course Details	Credits
<b>I</b>	<b>Ability Enhancement Compulsory Course - I</b>	English communication / Environmental Science	2
	Core course -1	Non-chordates I: Protista to Pseudocoelomates	4
	Core course -1 Practical	Non-chordates I: Protista to Pseudocoelomates Lab	2
	Core course – II	Perspectives in Ecology	4
	Core course - II Practical	Perspectives in Ecology Lab	2
	Generic Elective – 1	Animal Diversity	4
	Generic Elective - 1 Practical	Animal Diversity Lab	2
<b>II</b>	<b>Ability Enhancement Compulsory Course - II</b>	English communication / Environmental Science	2
	Core course – III	Non-chordates II: Coelomates	4
	Core course - III Practical	Non-chordates II: Coelomates Lab	2
	Core course - IV	Cell Biology	4
	Core course - IV Practical	Cell Biology Lab	2
	Generic Elective - 2	Aquatic Biology	4
	Generic Elective - 2 Practical	Aquatic Biology Lab	2
<b>III</b>	Core course – V	Diversity of Chordates	4
	Core course - V Practical	Diversity of Chordates Lab	2
	Core course – VI	Animal Physiology: Controlling and Coordinating Systems	4
	Core course - VI Practical	Animal Physiology: Controlling and Coordinating Systems Lab	2
	Core course - VII	Fundamentals of Biochemistry	4
	Core course - VII Practical	Fundamentals of Biochemistry Lab	2
	Skill Enhancement Course-1	Apiculture	2
	Generic Elective-3	Environment and Public Health	4
	Generic Elective Practical-3	Environment and Public Health Lab	2
<b>IV</b>	Core course – VII	Comparative Anatomy of Vertebrates	4
	Core course - VII Practical	Comparative Anatomy of Vertebrates Lab	2
	Core Course IX	Animal Physiology : Life Sustaining Systems	4
	Core Course IX Practical	Animal Physiology : Life Sustaining Systems Lab	4
	Core Course X	Immunology	4
	Core Course X Practical	Immunology Lab	2
	Skill Enhancement Course – 2	Sericulture / Aquarium fish keeping	2
	Generic Elective - 4	Insect Vector and Diseases	4
	Generic Elective - 4 Practical	Insect Vector and Diseases Lab	2
<b>V</b>	Core Course XI	Molecular Biology	4
	Core Course-XI Practical	Molecular Biology Lab	2
	Core Course-XII	Principles of Genetics	4
	Core Course-XII Practical	Principles of Genetics Lab	2
	Discipline Specific Elective - 1	Animal Behavior and Chronobiology	4
	Discipline Specific Elective - 1 Practical	Animal Behavior and Chronobiology Lab	2
	Discipline Specific Elective – 2	Biology of Insecta	4
	Discipline Specific Elective - 2 Practical	Biology of Insecta Lab	2

**Scheme for CBCS Curriculum in Zoology (Honours)**

Semester	Course Name	Course Details	Credits
VI	Core Course-XIII	Developmental Biology	4
	Core Course-XIII Practical	Developmental Biology lab	2
	Core Course-XIV	Evolutionary Biology	4
	Core Course-XIV Practical	Evolutionary Biology Lab	2
	Discipline Specific Elective - 3	Fish and Fisheries / Parasitology	4
	Discipline Specific Elective - 3 Practical	Fish and Fisheries / Parasitology Lab	2
	Discipline Specific Elective - 4	Endocrinology	4
	Discipline Specific Elective - 4 Practical	Endocrinology Lab	2

**2.3 Choices for Skill Enhancement Courses (SEC)**

Semester	Course	Choice
Sem -III	SEC-1	Apiculture
Sem -IV	SEC-II	Any one from 1. Sericulture 2. Aquarium fish keeping

**2.4 Choices for Discipline Specific Electives (DSE)**

Semester	Course	Choice
Sem-V	DSE-1	Animal Behaviour and Chronobiology
	DSE-2	Biology of Insecta
Sem-VI	DSE-3	Any one from 1. Fish and Fisheries 2. Parasitology
	DSE-4	Endocrinology

**2.5 Choices for Generic Elective Courses (GE)**

Semester	Course	Choice
Sem -I	Generic Elective- 1	Animal Diversity
Sem -II	Generic Elective- II	Aquatic Biology
Sem-III	Generic Elective- III	Environment and Public Health
Sem -IV	Generic Elective- IV	Insect vector and Diseases





## 2.6 Question pattern for Zoology Honours

### For 25 Marks

Sl No.	Questions to be answered	Out of	Marks of each question	Total Marks
1	5	8	1	5 x 1 = 5
2	2	4	5	2 x 5 = 10
3	1	2	10	1 x 10 = 10

### For 40 Marks

Sl No.	Questions to be answered	Out of	Marks of each question	Total Marks
1	5	8	2	5 x 2 = 10
2	4	6	5	4 x 5 = 20
3	1	2	10	1 x 10 = 10

## 2.7 Odd Semester Course ID

Semester	Course ID Internal	Course ID Theory	Course ID Practical	Paper Type	Course Title	Course code	Credit	Theory Marks	Practical marks
Semester – I	12601	12611	12621	Core –C1 (Hons)	Non-chordates I	UG/ZOOH/101/C-1	4 2	25	15
	12602	12612	12622	Core –C 2 (Hons)	Perspectives In Ecology	UG/ZOOH/102/C-2	4 2	25	15
	12604	12614	12624	GE –1 (Hons)	Animal Diversity	UG/ZOOH/103/GE-1	4 2	25	15
Semester –III	32601	32611	32621	Core –C 5 (Hons)	Diversity of Chordata	UG/ZOOH/301/C-5	4 2	25	15
	32602	32612	32622	Core –C 6 (Hons)	Animal Physiology: Controlling and Co-ordinating systems	UG/ZOOH/302/C-6	4 2	25	15
	32603	32613	32623	Core –C 7 (Hons)	Fundamental of Biochemistry	UG/ZOOH/303/C-7	4 2	25	15
	32605	32615	*****	SEC –T1 (Hons)	Apiculture	UG/ZOOH/305/SEC-1	2	40	****
	32604	32614	32624	GE–T3 (Hons)	Environment and Public Health	UG/ZOOH/304/GE-3	4 2	25	15
Semester –V	52601	52611	52621	Core C11 (Hons)	Molecular Biology	UG/ZOOH/501/C-11	4 2	25	15
	52612	52612	52612	Core- C12 (Hons)	Principles of Genetics	UG/ZOOH/502/C-12	4 2	25	15
	52606	52616	52626	DSE –1 (Hons)	Animal Behavior & Chronobiology	UG/ZOOH/503/DSE-1	4 2	25	15
	52607	52617	52627	DSE –2 (Hons)	Biology of Insecta	UG/ZOOH/504/DSE-2	4 2	25	15



## 2.8 Even Semester Course ID

Sem	Course ID Internal	Course ID Theory	Course ID Practical Exam	Paper Type	Paper Name	Course Code	Credit	Theory Marks	Practical marks
Semester -II	22601	22611	22621	C-3	ZOOLOGY - Non-chordates II	SH/ZOOH/201/C-3	4 2	25	15
	22602	22612	22622	C-4	ZOOLOGY - Cell-Biology	SH/ZOOH/ 202/C-4	4 2	25	15
	22604	22614	22624	GE-2	ZOOLOGY - ZOOLOGY: Aquatic Biology	SH/ZOO/ 203/GE-2	4 2	25	15
Semester -IV	42601	42611	42621	C-8	Comparative Anatomy of Vertebrates	SH/ZOO /401/C-8	4 2	25	15
	42602	42612	42622	C-9	Animal Physiology: Life Sustaining System	SH/ZOO /402/C-9	4 2	25	15
	42603	42613	42623	C-10	Immunology	SH/ZOO /403/C-10	4 2	25	15
	42604	42614	42624	GE-4	Insect Vectors and Diseases	SH/ZOO / 404/GE-4	4 2	25	15
	42605	42615	*****	Sec-2 (Hons)	Aquarium Fish Keeping	SH/ZOO/ 405/SEC-2	2	40	X
	42605	42615	*****	Sec-2 (Hons)	Sericulture	SH/ZOO/ 405/SEC-2	2	40	X
	42608	42618	42628	Prog (DSE)	Genetics and evolutionary Biology	SPZOO/ 401/C-1D	6	25	15
	42600	42610	*****	Prog (SEC-2)	Aquarium Fish Keeping (Economic Zoology)	SPZOO /404/ SEC-2	2	40	X
Semester -VI	62601	62611	62621	C-13	Developmental Biology	SH/ZOO/601/C-13	4 2	25	15
	62602	62612	62622	C-14	Evolutionary Biology	SH/ZOO/602/C-14	4 2	25	15
	62606	62616	62626	DSE-3	Fish & Fisheries	SH/ZOO/603/DSE-3	4 2	25	15
	62606	62616	62626	DSE-3	Parasitology	SH/ZOO/603/DSE-3	4 2	25	15
	62607	62617	62627	DSE-4	Endocrinology	SH/ZOO/604/DSE-4	4 2	25	15

**2.9 Summary Scheme for CBCS Curriculum**

Semester	Core Course (With Practical)	Generic Elective	Discipline Specific Elective	Skill enhancement Course	Ability enhancement compulsory course
<b>Sem-I</b>	C 1- Non Chordate 1 C 2- Ecology	GE1- Animal Diversity	*****	*****	Environmental Studies
<b>Sem-II</b>	C 3- Non Chordate II C 4- Cell Biology	GE2- Aquatic Biology	*****	*****	English / MIL
<b>Sem-III</b>	C 5- Diversity of Chordata C 6- Animal Physiology: Controlling and Co-ordinating systems C 7- Fundamental of Biochemistry	GE3- Environment and Public Health	*****	SEC 1- Apiculture	*****
<b>Sem-IV</b>	C 8- Comparative Anatomy of Vertebrate C 9- Animal Physiology: Life Sustaining System C 10- Immunology	GE4- Insect vector and Diseases	*****	SEC 2- Sericulture or Aquarium fish keeping	*****
<b>Sem-V</b>	C 11- Molecular Biology C 12- Principles of Genetics	*****	DSE 1—Animal Behaviour and Chronobiology DSE 2—Biology of Insecta	*****	*****
<b>Sem-VI</b>	C 13- Developmental Biology C 14- Evolutionary Biology:	*****	DSE 3-Fish and Fisheries or Parasitology DSE 4-Endocrinology	*****	*****



## 2.10 Programme Outcome (PO)

After successful completion of 6 Semesters with Zoology as Core subject students should enable themselves of -		
P O	Programme Outcome	Description
PO. 1	Sound knowledge in different fields of Zoology	Students are expected to learn the fundamental concepts, principles and processes underlying the academic field of Zoology with special reference to the characteristics of animal diversity, ecological aspects, comparative anatomy and development, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied zoology, aquatic biology, immunology, reproductive biology, insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, sericulture and microbiological relationship.
PO. 2	Professional skills	Professional skills in the field of Zoology in relation to academia and industry require sound knowledge of the core courses as well as related fields of study such as chemistry, physics, mathematics etc. and above all interest in studying with the habit of asking questions to find out the cause and effect. Therefore, there must be the sincerity from both the teachers and learners to extend curiosity and grasp knowledge.
PO. 3	Environmental awareness	Going through the courses as enshrined in the syllabus concerned students would generously and spontaneously develop the characteristics of thinking on the global environmental aspects.
PO. 4	Designing and conducting experiments to test a hypothesis	On obtaining wholesome knowledge from learning the courses it would be possible for the learners to step into higher learning which requires designing experiments to prove hypotheses.
PO. 5	Job opportunity	Biological Sciences today extend great opportunity towards sincere learners for healthy jobs in different fields beside academia such as health, medicines, research, biotechnological industry and such many. Therefore the students must be prepared in such a way so that they may able to face these competitive fields.



## 2.11 Programme Specific Outcomes (PSO)

PSO	Description
PSO. 1	<p><b>The core courses include diversified fields of life sciences viz:</b></p> <p>a) Overall concept of living organisms with special reference to animal kingdom; wherein it would be possible for the learners to have an idea of diverse group of animals, their structural aspects with functional anatomy .</p> <p>b) Concept of classifying these diversified groups of animals using taxonomical approaches. Evolution of animals are studied by following evolutionary principles.</p> <p>c) Idea of developing ecological concepts in relation to individual, population and community along with the roles in organizing ecosystems and other structural and functional components.</p> <p>d) Similarities in Biochemistry, physiology and molecular aspects of all living organisms are taught in the light of modern approaches to develop the concept and generate interest .</p> <p>e) Molecular biological parameters in the form of DNA, RNA and proteins and their similarities and uniqueness in all living organisms.</p> <p>f) Protective approaches of animals against infectious diseases termed as immunity are studied to develop global concept of immunity following immunological principles.</p> <p>g) Development of animals from fertilized embryo is studied in relation to amphibian and avian embryonic development to have an overall concept of developmental pattern in animals.</p> <p>h) Endocrine regulation and coordination of different physiological system are studied in an independent course in the form of endocrinology.</p> <p>i) Heredity and variation of animals are studied following the general principles of genetics. Therefore using these study materials it becomes possible for the learners to develop improved knowledge on the field.</p>
PSO.2	Applied zoology in the form of fish farming, poultry etc. are studied independently by including separate programme called department specific elective in broader perspective so that the learners become seriously devoted to the subject.
PSO. 3	Skill enhancement courses are introduced such as medical technology, Apiculture etc. to develop specific skill in the area of self development to start the learners own laboratories.
PSO. 4	Generic Elective courses have been incorporated as interdisciplinary to teach overall concept of the subject so that student from other department of study may choose the courses according to their interest.
PSO. 5	Students ripen their investigative proficiency so that they can open up the entrances of the future knowledge world.
PSO. 6	To help the students for development of essential academic skills like critical thinking, analytical reasoning, research skills to identifying various Invertebrate and Vertebrate fauna and their classification as well as to understand the relations among these organisms with an evolutionary perspective
PSO.7	Students will be able to analyze and solve the problems related to animal sciences without relying on assumptions and guesses.



<b>PSO 8</b>	Students will be able to make solutions of biological problems by experimentation and subsequent data processing by modern technologies and computer applications.
<b>PSO 9</b>	The programme will fortify the students to develop fundamental knowledge in biodiversity and their conservation, pollution of environment and their control measures.
<b>PSO 10</b>	They will be able to understand the basic zoological principles with critical understanding and analytical skills as well as to develop effective methods for experimentation and problem solving.
<b>PSO 11</b>	The programme will help the students to learn the safety measures in animal handling and management programmes in laboratories. Students will be able to learn the field survey for ecological studies as well as they will be capable of designing precise experimental setup for studying animal behaviour.
<b>PSO 12</b>	The programme will strengthen the students for developing laboratory skills for Genetics and Molecular Biology. The laboratory programme will enable them to learn the techniques for the qualitative as well as quantitative assays of bio molecules.
<b>PSO 13</b>	They will understand the importance and role of biodiversity and can recognize the economically important animals around us.
<b>PSO 14</b>	Students will be able to learn about different diseases, causative organisms, parasites, hosts, vectors as well as the basic principles of immunology including vaccinations and genetic basis of several diseases like cancer.
<b>PSO 15</b>	The programme will strengthen the students to understand the structure and function of the gene, chromosomes, genome, cell, tissue, organ and organ-system.
<b>PSO 16</b>	They will understand the importance of the physiological adaptations, development pathways, hormonal regulation of reproduction and other physiological mechanisms.
<b>PSO 17</b>	Another important programme outcome will be the ability of students to estimate various important environmental parameters like O <sub>2</sub> , CO <sub>2</sub> content, pH, water turbulence, temperature, salinity, nutrient content etc.
<b>PSO 18</b>	Some special courses of the programme will help the students to develop essential skill and practical knowledge in application of economic Zoology in fishery, sericulture, apiculture which will provide gainful employment and economic development.
<b>PSO 19</b>	Project work and field study provide them with an encouragement for self-learning.
<b>PSO 20</b>	Research Motivation is also another significant outcome that the students are endowed with on the completion of the programme.



### 3. Core Subjects Syllabus

Semester- I

**Core T1 - Non-chordates I: Protista to Pseudocoelomates****4 Credits****Course outcomes:**

1. This course includes the concept of living organisms which are grouped into six kingdoms and the idea behind such grouping. Knowing the differences among other five non-animal to that of animal kingdom enables to have a clear idea of animal characteristics.
2. To study animals in systematic pattern it needs to classify animal groups using taxonomical principles. Therefore Taxonomy is incorporated in the course.
3. The common structural pattern of all animals are considered in the form of symmetry.
4. The protozoans are animal protists therefore these find inclusion in studying zoology and this course includes Protozoans to Pseudocoelomates. Pseudocoelomates are triploblastic animals without true coelom and therefore the topic of development of coelome is also included. Thus non-chordate I contents teaches on the basics of animal characters and their organized study methods.

**Unit 1: Basics of Animal Classification**

1. Definitions: Classification, Systematics and Taxonomy: Taxonomic Hierarchy, Taxonomic types
2. Codes of Zoological Nomenclature; Principle of priority; Synonymy and Homonymy; Six kingdom concept of classification (Carl Woese)
3. Diversity of non-chordate and its significance

**Unit 2: Protista**

1. Protozoa:
  - a. General characteristics and classification up to phylum (according to Levine et. al., 1981) Locomotion in Protozoa with special reference to *Euglena*, *Paramoecium* and *Amoeba*; Conjugation in *Paramoecium*.
  - b. Life cycle and pathogenicity of *Plasmodium vivax* and *Entamoeba histolytica*

**Unit 3: Metazoa**

- a. Evolution of symmetry and segmentation in Metazoa

**Unit 4: Porifera**

1. General characteristics and classification up to classes (Hyman)
2. Canal system and spicules in sponges

**Unit 5: Cnidaria**

1. General characteristics and classification up to classes
2. Metagenesis in *Obelia*
3. Polymorphism in Siphonophora
4. Corals and coral reef diversity, function & conservation

**Unit 6: Ctenophora** General characteristics**Unit 7: Platyhelminthes**

1. General characteristics and classification up to classes
2. Life cycle and pathogenicity and control measures of *Fasciola hepatica* and *Taenia solium*

**Unit 8: Nematoda**

1. General characteristics and classification up to classes
2. Life cycle, pathogenicity and control measures of *Ascaris lumbricoides* and *Wuchereria bancrofti*
3. Parasitic adaptations in helminthes

**Note: Classification to be followed from Barnes and Ruppert 1994, 6<sup>th</sup> Edition****Reference Books**

- Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
- Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6th Ed. Brooks Cole
- Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates
- Mandal FB (2015), Human Parasitology 2nd Edition, PHI Learning
- Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
- Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
- Mayr, E. & Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
- Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press
- Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill
- Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata

**Core PI - Non-Chordates I Lab****2 credits****Course Outcomes**

The Laboratory on the course approaches to teach the diverse kinds of animals from protozoans to pseudocoelomates including poriferans, cnidarians and helminthes in between by observing the real animal groups and their identifying characters.

**Practicals**

1. Identification of following specimen
  - a. *Amoeba*, *Euglena*, *Entamoeba*, *Opalina*, *Paramecium*, *Plasmodium*,
  - b. *Sycon*, Neptune's Cup, *Fasciola*, *Taenia* and *Ascaris*
  - c. *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Alcyonium*, *Gorgonia*, *Metridium*, *Pennatula*, *Fungia*, *Madrepora*.
2. Whole mount preparation of *Euglena*, *Amoeba*, and *Paramecium*.
3. Staining and mounting of any protozoa/helminth from gut of cockroach.
4. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |           |
|---|-----------|
| 1. Identification with reasons (any three):<br>(From Item No. 1; maximum one from each group) | 9 [3×3]   |
| 2. Staining/Mounting (any one) (From Item no. 2 and 3):                                       | 4 [2+1+1] |
| 3. Submission of Laboratory note book:  | 2         |

**Note:**

- Q1. Sc. name :1 mark, Reasons: 2 marks  
Q2. Staining: 2 marks, Drawing: 1 mark, labeling: 1 mark

**Suggested readings:**

- Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata  
Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications  
Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology

**Core T2 - Perspectives in Ecology****4 Credits****Course outcomes:**

Perspective in Ecology deals with important concepts of ecological study, related to ecosystem sustenance, population and community interactions etc. fulfilling criteria to study environment and living organisms functional mechanisms.

**Unit 1: Introduction to Ecology**

History of ecology, Autecology and synecology, Levels of organization, Study of Physical factors (Temperature and Light), Laws of limiting factors, The Biosphere. Levels and Depletion of Biodiversity

**Unit 2: Ecosystem**

Types of ecosystem w.r.t forest and marine ecosystem; Food chain: Detritus and grazing food chains, Foodweb, Energy flow through the ecosystem with special emphasis on Linear and Y- shaped food chain, Ecological pyramids and Ecological efficiencies  
Biogeochemical cycle w.r.t. Carbon  
Cycle and Nitrogen cycle

**Unit 3: Community**

Community characteristics: species diversity, abundance, dominance, richness  
Concept of community stratification, Ecotone and edge effect. Ecological succession with one example(Forest)

**Unit 4: Population**

Population: Characteristics, growth forms, exponential and logistic growth, equation and patterns, r and K strategies  
Population regulation - density-dependent and independent factors  
Population Interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition.



**Unit 5: Applied Ecology**

Concept of wild life

Biodiversity, Wildlife Conservation (*in-situ* and *ex-situ* conservation)

Management strategies for tiger conservation; Wild life protection act (1972)

**Unit 6: Biometry**

Measurement of Central Tendency (Mean, Median, Mode)

Measures of Dispersion (Standard Deviation, Standard error)

**Reference Books**

Cain, Bowman & Hacker (2014) Ecology, 3rd edition. Sinauer associates

Chapman, R. L. and Reiss, M. J. (2000). Ecology - Principles & Application. Cambridge University Press

Dash, M. C., (2001). Fundamental of Ecology. 2nd Ed. Tata McGraw-Hill Company

Kormondy, E. J. (2002). Concepts of Ecology. 4th Indian Reprint, Pearson Education

Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.

Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole

Robert Leo Smith Ecology and field biology Harper and Row publisher

Russel, P.J., Wolfe, L. S., Hertz, P.E. Starr, C. & McMillan, B. (2008). Ecology

Stilling P (2009) Ecology: Theories & Application 4th Edition, Prentice Hall of India.

Van Dyke, F. (2008). Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science and Business Media.

**Core P2 - Perspectives in Ecology Lab****2 Credits****Course outcomes:**

1. The laboratory aspect of the course is designed in such a way to develop idea on planktonic characters which are important constituents of aquatic food chain.
2. Beside there is the provision for study for community by enumeration of kinds and number of species present in a designated area.
3. Dissolved O<sub>2</sub> and CO<sub>2</sub> content of water are also the topics to have the concept of polluted water.
4. Field visit to National Park/Biodiversity Park/Wild life sanctuary is included due to the fact that the students may be exposed to reality of the idea behind such measures and may also be competent enough to prepare report of their visit.

All these are included by taking into consideration on the limitation of undergraduate laboratory infrastructure of rural colleges.

**Practicals**

1. Determination of population density in a natural / hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
2. Study of an aquatic ecosystem: Zooplankton, Determination of pH, and Dissolved Oxygen content(Winkler's method), Chemical Oxygen Demand and free CO<sub>2</sub>
3. Report on a visit to Zoological Park/National Park/Biodiversity Park/Wild life sanctuary
4. Submission of Laboratory Note Book

**- Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |          |
|---|----------|
| 1. Experiment (from Item no. 1):  | 5        |
| 2. Experiment (from Item no. 2; pH or free O <sub>2</sub> or free CO <sub>2</sub> estimation) | 5 (2+3)* |
| 3. Report on Excursion:   | 3        |
| 4. Submission of Laboratory note book:  | 2        |

**\*Note**

Q 2. Principle: 2 marks and result: 3 marks

**Suggested Reading**

Desharnais Robert, Jeffrey Bell (2001) 'Ecology Student Lab Manual, Biology Labs', Benjamin

CummingsDarrell S Vodopich,(2009), 'Ecology Lab Manual', McGraw-Hill Higher Education

Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books & Allied (P) Ltd

**Semester- II****Core T3 - Non-Chordates II: Coelomates****4 Credits****Course outcomes:**

Non-chordates II includes topics of metamerism in animals with special reference to annelids to know the metamerism in all higher groups which is not present in earlier groups already studied in non-chordate-I.

The course also includes classificatory schemes, structural and functional aspects of the non-chordate groups from annelids to echinoderms.

**Unit 1: Introduction**

Coelom: Types, Evolution and significance

Concept of metamerism

**Unit 2: Annelida**

1. General characteristics and classification up to classes
2. Excretion in Annelida through nephridia.
3. Reproduction in earthworm.

**Unit 3: Arthropoda**

1. General characteristics and classification up to classes
2. Respiration (Gills in prawn and trachea in cockroach)
3. Social life in termite
4. Compound eye in prawn

**Unit 4: Onychophora**

General characteristics and Evolutionary significance of *Peripatus*

**Unit 5: Mollusca**

1. General characteristics and Classification up to classes
2. Nervous system and torsion in Gastropoda
3. Feeding and respiration in *Pila* sp

**Unit 6: Echinodermata**

1. General characteristics and Classification up to classes
2. Water-vascular system in *Asterias*
3. Larval forms in Echinodermata
4. Affinities with Chordates

**Unit 7: Hemichordata**

1. General characteristics of phylum Hemichordata.
2. Relationship with non-chordates and chordates: Evolutionary significance

**Note: Classification to be followed from Barnes and Ruppert 1994, 6<sup>th</sup> Edition**

**Reference Books**

- Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
- Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6th Ed. Brooks Cole
- Brusca, R. C. & Brusca, G. J. (2002). Invertebrates. 4th Ed. Sinauer Associates
- Mandal FB (2015), Human Parasitology 2nd Edition, PHI Learning
- Kapoor, V. C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
- Mayr, E. (1969). Principles of Systematic Zoology. Tata McGraw-Hill.
- Mayr, E. & Ashlock, P. D. (1991). Principles of Systematic Zoology. 2nd Ed., McGraw-Hill.
- Meglitsch, P. A. & Schram, F. R. (1991). Invertebrate Zoology. Oxford University Press
- Pechenik, J. A. (1998). Biology of the Invertebrates, 4th Ed. McGraw Hill
- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition.
- Sinha, K. S., Adhikari, S., & Ganguly, B. B. Biology of Animals. Vol. I. New Central Book Agency. Kolkata

**Core P3 Non-Chordates II: Coelomates Lab****2 Credits****Course outcomes:**

1. The course would capacitate the students in identification of a wide range of Invertebrate specimens.
2. Life cycle stages of insects are extended to feel the reality of insect development.
3. Dissection and demonstrations of different invertebrate organ systems add to the knowledge of theoretical study

**Practicals**

1. Identification of following specimens:
  - a. *Aphrodite, Nereis, Heteronereis, Sabella, Chaetopterus, Pheretima, Hirudinaria*
  - b. *Carcinoscorpius, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Peripatus*
  - c. *Chiton, Dentalium, Pila, Doris, Unio, Pinctada, Sepia, Octopus, Nautilus, Asterias, Ophiura, Echinus, Cucumaria and Antedon*
  - d. *Balanoglossus*
2. Identification of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
3. Dissection, drawing and labelling of digestive system and septal nephridia of earthworm
4. a. Mounting of mouth parts of *Periplaneta*  
b. Dissection: digestive system and nervous system of *Periplaneta*
5. Submission of a Project Report on life cycle stages of any insect.
6. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |            |
|---|------------|
| 1. Identification with reasons (any three):<br>(Two from Item No. 1 and one from Item no.2.)  | 7 [3+3+1]* |
| 2. Dissection (any one) (From Item no. 3 or 4)  | 4 {2+1+1}* |
| 3. Submission of a project report along with the life cycle stages of any insect (Item no. 5) | 2          |
| 4. Submission of laboratory note book:  | 2          |

**\*Note:**

- Q1. For Item (1), Sc. name:1 mark and Reasons: 2 marks. For Item (2) 1 mark is allotted for both identification and characters.  
Q2. Dissection :2 marks ; drawing and labelling : 1 mark each

**Suggested Reading**

- Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata  
Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications  
Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books & Allied (P) Ltd

**Core T4 Cell Biology****4 Credits****Course outcomes:**

1. The course intends to develop concept of prokaryotic and eukaryotic cellular structures and functions by considering structural components of eukaryotic cellular complexity as well as prokaryotic cellular simplicity although both kinds of cells perform similar functions for sustenance.
2. Extracellular matrices of eukaryotic cells are incorporated to study cell-cell interactions in tissues, and cell signaling for important cellular functions.
3. Cell division is very important part of cell biology study requiring unicellular organisms to grow in numbers and multicellular organisms for growth and development.
4. Normal cell death(apoptosis) and extraordinary cell division(tumor growth) are other aspects of cellular studies to conclude the course

**Unit 1: Microscopy**

1. Light Microscopy: Principle and procedure of Bright field, Phase contrast and Fluorescence microscope
2. Electron Microscopy: Principle and procedure of TEM and SEM

**Unit 2: Plasma Membrane**

1. Ultra structure of Plasma membrane: Fluid mosaic model
2. Transport across membrane: Active and Passive transport, Facilitated transport
3. Cell junctions: Tight junctions, Gap junctions, Desmosomes

**Unit 3: Cytoplasmic organelles**

1. Structure and Functions: Endoplasmic Reticulum, Ribosome, Golgi Apparatus, Lysosomes
2. Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis,
3. Inhibitors and un-couplers of Electron Transport System
4. Peroxisomes: Structure and Functions
5. Protein sorting and mechanisms of vesicular transport

**Unit 4: Nucleus**

1. Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus
2. Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)

**Unit 5: Cell Division**

1. Cytoskeletal structures,
2. Centrosome structure and function
3. Accessory proteins of microfilament & microtubule
4. A brief idea about molecular motors
5. Mitosis and Meiosis: Basic process and their significance

**Unit 6: Cell cycle and cancer**

1. Cell cycle and its regulation
2. Cancer (Concept of oncogenes and tumor suppressor genes with special reference to p53, Retinoblastoma and Ras and APC).

**Unit 7: Cell Signalling**

1. Cell signalling transduction pathways; Types of signalling molecules and receptors
2. GPCR and Role of second messenger (cAMP)
3. Extra cellular matrix-cell interactions
4. Apoptosis

**Reference Books**

- Albert Bruce, Bray Dennis, Levis, Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press and Sunderland, Washington, D.C.;



Sinauer Associates, MA. Hardin, J. Bertoni, G and Klein smith, J. L. (2012). Becker's World of the Cell. 8th Edn, Pearson Benjamin Cummings, San Francisco.

Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman

Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.

Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman

Plopper, G, D. Sharp, Siroski, E (2015) Lewin's Cell 3rd Edition—Johns & Bartlett Publishers

Pollard and Earnshaw (2007). Cell Biology. 2nd. Edn Saunders.

Reed, J.C. and Green, D.R. (2011). Apoptosis: Physiology and Pathology. Cambridge Univ. Press

Weinberg R.A. (2014). Biology of Cancer. 2nd edition. Garland Science, Taylor and Francis

De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology (8th edition) Lippincott Williams and Wilkins, Philadelphia.

### Core P4 Cell Biology Lab

2 Credit

#### Course outcomes:

Testicular cells of insects and root tips meristem of onions are used for cell division study with reference to meiosis and mitosis respectively. Thus the incumbents are required to prepare tissues, prepare suitable stains for the use in study, and handle microscopes for the purpose.

In addition to the above experiments the course also includes Barr body study using female cheek epithelium.

#### Practicals

1. Drawing of ultrastructure of cell and different organelles (from photographs provided)
2. Familiarization with the student's light microscope and stereo-binocular microscope; preparation of aceto-orcein/ acetocarmine stain
3. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
4. Preparation and identification of various stages of meiosis from grasshopper testis
5. Preparation of permanent slides of Barr body from cheek epithelium
6. Submission of Laboratory Note Book

#### Distribution of Marks

##### Examination Pattern:

Full marks: 15

- |   |          |
|---|----------|
| 1. Identification of any ideal stages of mitosis and meiosis (any two):                 | 4 (2+2)* |
| 2. Squash preparation, staining and identification of any stage from mitosis or meiosis | 5 (3+2)* |
| 3. Preparation of Barr body   | 4 (3+1)* |
| 4. Submission of laboratory note book:  | 2        |

##### \*Note:

Q1. Identification of the stage: ½ mark and characters: 1½

marks Q2. Preparation: 3 marks ; identification and drawing:

2 marks Q3. Preparation: 3 marks and drawing: 1 mark.

#### Suggested Reading

Gupta R., Makhija S., Toteja R. (2018) Cell Biology : Practical Manual Paperback, Prestige Publishers

Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi

Publications Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books and Allied (P) Ltd

**Semester -III****Core T5 - Diversity of Chordata****4 Credits****Course Outcomes:**

The course approaches to learn overall concept of diverse group of chordates from notochordal to vertebral chordates by incorporation of defined identifying characters, classificatory schemes and subject of special interest in each group.

**Unit 1: Introduction to Chordates**

Origin of Chordate (Dipleurula concept and the Echinoderm theory)

Diversity of Chordata and its significance

**Unit 2: Urochordata and Cephalochordata**

1. General characteristics and classification of Urochordata and Cephalochordata up to Classes.

2. Retrogressive metamorphosis in *Ascidia*.

3. Chordate Features and Feeding mechanism in *Branchiostoma*

**Unit 3: Agnatha**

General characteristics and classification of cyclostomes up to order

**Unit 4: Pisces**

1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses

2. Accessory respiratory organ and migration in fishes

3. Structure and function of Swim bladder

4. Osmoregulation in fishes.

**Unit 5: Amphibia**

1. General characteristics and classification up to living Orders.

2. Metamorphosis and parental care in Amphibia

**Unit 6: Reptilia**

1. General characteristics and classification up to living Orders.

2. Poison apparatus and biting mechanism in snakes

**Unit 7: Aves**

1. General characteristics and classification up to Sub-Classes

2. Exoskeleton and migration in birds

3. Principles and aerodynamics of flight

**Unit 9: Mammals**

1. General characters and classification up to living orders

2. Affinities and phylogeny of Monotremata

3. Exoskeletal derivatives of mammals

4. Adaptive radiation in marsupials

5. Echolocation in micro chiropterans and cetaceans

**Unit 10: Zoogeography**

Plate tectonic and Continental drift theory; Zoogeographical realms; distribution of birds and mammals in major six realms

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Nobel (1924).

**Reference Books**

Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.

Futuyama, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.



- Hall B.K. and Hallgrímsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
- Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.
- Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.
- Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.
- Mandal FB (2013) Vertebrate Zoology, Oxford and IBH Co Pvt Ltd, New Delhi
- Nelson, J.S., (2006): Fishes of the World, 4th Edn., Wiley.
- Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Wiliam (Eds.) 7th Ed. Macmillan Press, London.
- Pough H. Vertebrate life, VIII Edition, Pearson International.
- Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.
- Sinha, K. S., Adhikari, S., Ganguly, B. B. & BharatiGoswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.
- Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.

**Core P5 – Diversity of Chordata Lab****2 Credits****Course Outcomes:**

This course enables students to know the identity of a large group of chordates from Cephalochordates to Mammals and to develop basic skill in Vertebrate dissection.

**Practicals**

1. Identification of following specimen
  - a. *Branchiostoma*
  - b. *Petromyzon, Myxine*
  - c. *Scoliodon, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Anabas*
  - d. *Necturus, Bufo, Hyla, Alytes, Axolotl, Tylotriton,*
  - e. *Chelone, Hemidactylus, Uromastix, Chamaeleon, Ophisaurus, Draco, Bungarus, Vipera, Naja, Hydrophis*
  - f. *Pteropus, Funambulus, Bandicota*
2. Dissect out Pecten from Fowl head
3. Dissect out brain and pituitary of carp
4. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |           |
|---|-----------|
| 1. Identification with reasons (any three):<br>(From Item no. 1; maximum 1 from each group) | 9 [3×3]   |
| 2. Dissection (any one) (From Item no. 2 or 3)  | 4 [2+1+1] |
| 3. Submission of laboratory note book:  | 2         |

**\*Note:**

- Q1. Sc. Name:1 mark ; Reasons: 2 marks
- Q2. Dissection: 2 marks, drawing and labelling :1 mark each

**Suggested Reading**

- Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
- Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications
- Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books & Allied (P) Ltd

**Core T6 Animal Physiology: Controlling & Coordinating Systems****4 Credits****Course outcomes:**

This course is designed in such a way so that an idea would develop on controlling and coordinating parameters of physiological systems, for instance, types and functions of all tissues along with endocrine organs which together control and coordinate all the systems of organisms such as human being.

**Unit 1: Tissues**

Classification, structure and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

**Unit 2: Bone and Cartilage**

Structure and types of bones and cartilages

**Unit 3: Muscular system**

Characteristics of muscle fibre, Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction;

**Unit 4: Nervous System**

Structure of neuron, propagation of nerve impulse across the myelinated and unmyelinated nerve fibers; Types of synapse. Synaptic transmission and Neuromuscular junction, role of neurohormone in vertebrates

**Unit 5: Reproductive System**

Histology of testis and ovary, Physiology of Reproduction (estrus and menstrual cycle)

**Unit 6: Endocrine System**

1. Classification of hormones; Mechanism of Hormone action
2. Histology and function of pituitary, thyroid, pancreas and adrenal
3. Signal transduction pathways for steroid and non-steroid hormones in brief
4. Placental hormones

**Reference Books**

- Cormack, D.H (2003). PDQ Histology. B.C. Decker Ins., London 4. Gartner and Hiatt (2011). Concise Histology. Saunders Elsevier
- Cui, Naftel, Daley, Lynch, Haines, Yang and Fratkun (2011). Atlas of Histology with Functional and Clinical Correlations. Lippincott, Williams and Wilkins.
- David Randall and Warren Burggren (2001) Eckert Animal Physiology, 5th edition. W.H.Freeman.
- Fawcett Don, Jensch Ronald (2002) Bloom & Fawcett's Concise Histology 2nd Edition, CRC Press;
- Gunasegaran, JP (2010). A Text book of Histology and a Practical Guide. Elsevier
- Junquera and Cameiro (2005). Basic Histology: Text and Atlas.
- Randall, D. and Warren Burggren (2001) Eckert Animal Physiology 4th edition. W.H. Freeman.
- Ross H & Pawlina W (2015), Histology: A Text and Atlas With Correlated Cell and Molecular Biology 6th Edition, Lippincott Williams & Wilkins.
- Schmidt-Nielsen (2002) Animal Physiology: Adaptation and Environment. 5th Edition. Cambridge University Press
- Sembulingam and Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi
- Vasudeva and Mishra (2014). Inderbir Singh's Text book of Human Histology 7th Edn Jaypee Publisher N. Delhi



**Core P6- Animal Physiology: Controlling & Coordinating Systems Lab****2 Credits****Course Outcomes:**

This course teaches histochemistry using microtomical section of tissues , recording of simple muscle twitch by Kymograph as well as identification of histological slides of various Mammalian tissue sections.

**List of Practical**

1. Identification of permanent slides: TS of Mammalian Skin, Bone, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid, Intestine, Lung, Liver and Kidney
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
3. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |  |   |       |
|--|---|-------|
| 1. Identification with reasons (any two; From Item no. 1):   | 6 | [3+3] |
| 2. Preparation (tissue sectioning/ staining) from Item no 2: | 4 |       |
| 3. Mounting (any one from Item no. 2):                       | 3 |       |
| 4. Laboratory note book:                                     | 2 |       |

**\*Note:**

Q1. Identification: 1 mark , Reasons: 2 marks

**Suggested Reading**

Scudamore C.L. (2014). A Practical Guide to the Histology of Mouse. Wiley BlackwellPal GK,

Pal P (2016) Textbook of Practical Physiology. 4<sup>th</sup> Edition, University Press

Brancroft JD, Gamble M (2008) Theory and practice of histological techniques .6<sup>th</sup> edition, Elsevier Publication

**Core T7 Fundamentals of Biochemistry****4 Credits****Course Outcomes:**

1. The course extends to learn structures and functions of biological macromolecules such as polysaccharides, proteins, lipids, nucleic acids such as DNA and RNAs and their monomeric units or other details as well as metabolism.
2. In addition to these study of enzymes which catalyze biochemical /metabolic reactions are also incorporated to conceptualize the tremendous power of enzymatic reactions.

**Unit 1: Techniques used in Biochemistry**

1. Centrifugation (basic principle)
2. Colorimetry, Spectrophotometry (principle and procedure)
3. Chromatography: Gel filtration, Ion exchange, Affinity chromatography (principle and procedure)

**Unit 2: Carbohydrates**

1. Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides: Derivatives of Monosachharides
2. Optical Isomerism in Carbohydrate
3. Carbohydrate metabolism: Glycolysis, Citric acid cycle, Pentose phosphate pathway, Gluconeogenesis

**Unit 3: Lipids**

1. Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpenoids.
2. Lipid metabolism:  $\beta$ -oxidation of fatty acids (saturated and unsaturated)

**Unit 4: Proteins**

1. Amino acids: Structure, classification, General -and Electro chemical properties of  $\alpha$ -amino acids; Physiological importance of essential and non-essential amino acids
2. Proteins: Bonds stabilizing protein structure; Levels of organization
3. Protein metabolism: Transamination, Deamination, Urea cycle, Fate of carbon skeleton of Glucogenic and Ketogenic amino acids

**Unit 5: Nucleic Acids**

1. Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids
2. Types of DNA and RNA, Complementarity of DNA, Hypo- Hyperchromaticity of DNA
3. Basic concept of nucleotide metabolism

**Unit 6: Enzymes**

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Michaelis-Menten equation, Lineweaver-Burk plot; Factors affecting rate of enzyme-catalyzed reactions; Enzyme inhibition; Allosteric enzymes and their kinetics

**Reference Books**

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York
- Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
- Das, D. (2000). *Biochemistry*. Central Book Agency, Kolkata
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, II Edition, BIOS Scientific Publishers Ltd., U.K.
- 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.
- Rodwell (2018) *Harpers Illustrated Biochemistry*, 31<sup>st</sup> Edn, Mc Graw Hill
- Sathyanarayana U. and Chakrapani, (2002). *Biochemistry –Books & Allied (P) Ltd, Kolkata*
- Voet. D & Voet. J.G, Pratt CW (2012). *Principles of Biochemistry –4th edition, 2004, John Wiley & Sons, Inc.*
- 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 Pub.
- Zubay G.L, (1998). *Biochemistry –4th edition, Mc Graw-Hill*

**Core P7 Fundamentals of Biochemistry Lab****2 Credits****Course Outcomes:**

This course will enable students to learn a number of experimental techniques like qualitative test of functional groups in biomolecules, quantitative estimation of protein, basic principles of paper chromatography and its use for mixture of amino acids separation as well as estimation of enzymatic activity.

**Practicals**

1. Qualitative tests of functional groups in carbohydrates (Benedict), proteins (Biuret) and lipids (Saponification).
  2. Quantitative estimation of protein by Lowry Method
  3. Study the enzymatic activity of amylase (Effect of temperature)
  4. Paper chromatography of amino acid.
  5. Submission of Laboratory Note Book
- 

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |   |
|---|---|
| 1. Qualitative Test (any one; From Item no. 1):     | 3 |
| 2. Quantitative estimation of protein (Item no. 2): | 6 |
| 3. Experiment (From Item no. 3 or 4)                | 4 |
| 4. Submission of laboratory note book               | 2 |

**\*Note:**

- Q1. Principle: 1 mark and result 2 marks
- Q2. Principle 2 marks and result 4 marks
- Q3. Principle 1 mark and result 3 marks

**Suggested Reading:**

- Damodaran G K (2016). Practical Biochemistry, 2nd edition Jaypee Brothers Medical Publishers;Singh SP  
(2013). Practical Manual of Biochemistry. 7th edition, CBS Publishers & Distributors

**Semester -IV****Core T8 Comparative Anatomy of Vertebrates****4 Credits****Course Outcomes:**

The course is developed in such a way to extend knowledge of evolutionary aspect of anatomical structural requirement in different vertebrate groups.

**Unit 1: Integumentary System**

Structure, function and derivatives of integument in amphibian, birds and mammals

**Unit 2: Skeletal System**

General idea of axial and appendicular skeleton; Basic idea of jaw suspension and visceral arches.

**Unit 3: Digestive System**

Ruminating stomach; dentition in mammals

**Unit 4: Respiratory System**

Respiratory organs in fish, amphibian, and birds

**Unit 5: Circulatory System**

Comparative account of heart and aortic arches

**Unit 6: Urinogenital System**

Archinephros, Pronephros, Mesonephros and Metanephros  
Evolution of urinogenital ducts, Types of mammalian uteri

**Unit 7: Nervous System**

Comparative account of brain, Cranial nerves in mammals

**Unit 8: Sense Organs**

Classification of receptors

**Reference Books**

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 (1988) . Analysis of Vertebrate Structure. 3<sup>rd</sup> Edition, John Wiley and Sons

Saxena, R.K. & Saxena, S.C. (2008): Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

**Core P8 Comparative Anatomy of Vertebrates Lab****2 Credits****Course Outcomes:**

1. The course compares the skeletal structures of different vertebrate such as skull of Toad, Pigeon and Guineapig. Vertebrae and girdle bones of the above mentioned animals as well as carapace and plastron as hard covering of turtle.
2. Beside these comparative structural study of skeleton the syllabus also includes staining of different types of scales in fishes and dissection to demonstrate certain vertebrate nervous and circulatory systems.

**Practicals**

1. Identification of disarticulated skeleton of Toad, Pigeon and Guineapig [Skull, Vertebrae (Atlas, Axis) and typical vertebrae of procoelous, heterocoelous, amphicoelous and acoelous type]; Pectoral girdle, Pelvic girdle], Skull of Dog
2. Identification of carapace and plastron of turtle (Model/Chart)
3. Staining and mounting of placoid, cycloid and ctenoid scales
4. Dissection: Afferent branchial arterial system and IX and Xth cranial nerves of carp
5. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |            |
|---|------------|
| 1. Identification with reasons (any three; From Item no. 1,2) | 6 (2+2+2)* |
| 2. Mounting and staining (Item no. 3).                        | 2          |
| 3. Dissection (any one; From Item no. 4):                     | 5 [3+1+1]* |
| 4. Submission of laboratory note book:                        | 2          |

**\*Note:**

- Q1. Identification: ½ mark and reasons: 1½ marks
- Q3. 3 marks for dissection and 1 mark each for drawing and labelling

**Suggested Readings:**

- Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
- Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications
- Sinha, J.K., Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books & Allied (P) Ltd

**Core T9 Animal Physiology: Life Sustaining Systems****4 Credits****Course Outcomes:**

Life sustaining system of physiology deals with the systems which are essential for the sustenance of life, including, digestive, respiratory, circulatory, renal system whereas controlling and coordinating systems regulate and coordinate these systems. Therefore, with the inclusion of both in the syllabus fulfil the physiology syllabus.

**Unit 1: Concept of life sustenance****Unit 2: Physiology of Digestion**

Structural organization and functions of gastrointestinal tract and associated glands: Mechanical and chemical digestion of food along with the role of digestive enzymes; absorption of Carbohydrates, Lipids, Proteins and Nucleic Acids

**Unit 3: Physiology of Respiration**

Mechanism of Respiration, transport of Oxygen and Carbon dioxide in blood, Dissociation curves and the factors influencing it, carbon monoxide poisoning

**Unit 4: Physiology of Circulation**

1. Components of Blood and their functions; Structure and functions of haemoglobin
2. Haemostasis; Blood clotting system
3. Haemopoiesis; Basic steps and its regulation
4. Blood groups; ABO and Rh factor

**Unit 5: Physiology of Heart**

1. Structure of mammalian heart, Coronary Circulation, Structure and working of conducting myocardial fibres, Origin and conduction of cardiac impulses
2. Cardiac Cycle and cardiac output
3. Blood pressure and its regulation

**Unit 6: Thermoregulation & Osmoregulation**

1. Physiological classification of vertebrates based on thermal biology.
2. Extra-renal osmoregulatory organs in vertebrates

**Unit 7: Renal Physiology**

Structure of Kidney and its functional unit, Mechanism of urine formation, Regulation of acid-base balance

**Reference Books**

- Gunstream, S.E. (2010). Anatomy and Physiology with integrated study guide. 4th Edn., Mc Graw Hill
- Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Herculat Asia PTE Ltd. W.B. Saunders Company.
- Randall, D. and Warren Burggren (2001) Eckert Animal Physiology 5th edition. W.H. Freeman.
- Schmidt-Nielsen (2002) Animal Physiology: Adaptation and Environment. 5th Edition. Cambridge University Press
- Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi
- Sherman A J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
- Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
- Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills
- Victor P. Eroschenko. (2008). Di Fiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
- Chatterjee C.C. (2020) Human physiology: VOL 1 & 2, 13ED, CBS publishers.

**Core P9 -Animal Physiology: Life Sustaining Systems Lab****2 Credits****Course Outcomes:**

1. This course teaches to enumerate the red blood cells and to learn total and differential count of white blood cells using haemocytometer.
2. The course also teaches to estimate haemoglobin content using Sahli's haemoglobinometer.
3. Beside these, determination of ABO Blood group, preparation of haemin crystals and recording of blood pressure using a sphygmomanometer are the other important methods of studies included in the syllabus.

**Practicals**

1. Enumeration of red blood cells and white blood cells using haemocytometer (TC)
2. Estimation of haemoglobin using Sahli's haemoglobinometer
3. Determination of ABO Blood group
4. Preparation of haemin crystals
5. Recording of blood pressure using a sphygmomanometer
6. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |                      |
|---|----------------------|
| 1. Experiment (any one; From Item no. 1 or 2):      | 8 [6+2] *            |
| 2. Experiment (any one; From Item no. 3 or 4 or 5): | 5 [(3+1+1)/ (4+1)] * |
| 3. Submission of laboratory note book:              | 2                    |

**\*Note:**

Q1. For preparation 6 marks and for result 2 marks

Q2. For item no. (3 and 4): preparation 3 marks and 1 mark each for drawing and labelling. For item no. (5), 4 marks for procedure and 1 mark for comment.

Pal GK, Pal P (2016) Textbook of Practical Physiology. 4th Edition, University Press

Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books & Allied (P) Ltd

**Core T10 Immunology****4 Credits****Course Outcomes:**

The course on immunology deals with the basic principles innate and adaptive Immunity. It also extends clear knowledge of antigenicity and immunogenicity, cells and tissues involved for immunological response, structure and types of Immunoglobulins, Major Histocompatibility Complex, Cytokines and Complement System as well as assay systems for immunoassays.

**Unit 1: Overview of Immune System**

Basic concepts of health and diseases, Historical perspective of Immunology

**Unit 2: Innate and Adaptive Immunity**

Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral).

**Unit 3: Antigens**

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

**Unit 4: Immunoglobulins**

Structure and functions of major classes of immunoglobulins, Antigen- antibody interactions, Immunoassays (ELISA and RIA), Hybridomatechnology, concept of monoclonal antibody

**Unit 5: Major Histocompatibility Complex**

Structure and functions of MHC molecules. Structure of T cell Receptor and its signalling

**Unit 6: Cytokines**

Types, properties and functions of cytokines

**Unit 7: Complement System**

Components and pathways of complement activation.

**Unit 8: Hypersensitivity**

Gell and Coombs' classification and brief description of various types of hypersensitivities

**Unit 9: Vaccines**

Various types of vaccines: Active & passive immunization (Artificial and natural)

**Reference Books**

- Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology. V Edition. Saunders Publication
- Abbas, K.Abul and Lechtman H. Andrew (2011.) Basic Immunology: Functions and Disorders of Immune System. Saunders Elsevier Publication.
- Delves, Martin, Burton and Roitt (2006). Roitt's Essential Immunology. 11th Edn. Blackwell Pub.Khan FH (2011) The Elements of Immunology Pearson
- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). Immunology, VI Edition. W.H. Freeman and Company.
- Mohanty, SK and Leela, KS (2014). Text book of Immunology. 2nd Edn. Jaypee Pub. N. Delhi
- Parija, SC (2012). Text book of Microbiology and Immunology. 2nd Edn. Elsevier.
- Playfair, JHL and Chain, BM (2001) Immunology at a glance. 7 th Edn. Blackwell Pub.
- Shetty, N. (2005). Immunology: Introductory Textbook. 2nd Edn. , New Age Internatl. Pub. N. Delhi
- Virella, G ( 2007). Medical Immunology 6th Edn. Informa Healthcare



**Core P 10 Immunology Lab****2 Credits****Course Outcomes:**

This course teaches to identify lymphoid organs of human, to identify histological sections of spleen, thymus and lymph nodes, Preparation of stained blood film to study various types of white blood cells and evaluation of clotting time and bleeding time of human blood from student to students.

**Practicals**

1. Identification of lymphoid organs of human (Model/Photograph).
2. Identification of histological slides: T.S of spleen and thymus
3. Preparation of stained blood film to study various types of white blood cells.
4. Clotting time (CT), Bleeding time (BT) of human blood
5. Submission of Laboratory Note Book

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**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |   |             |
|---|-------------|
| 1. Identification with reasons (any two; From Item no. 1 & 2) | 4 (2+2) *   |
| 2. Preparation of stained blood film [from item 3]            | 6 (4+1+1) * |
| 3. Experiment (any one; From Item no. 4):                     | 3 (2+1) *   |
| 4. Laboratory note book:                                      | 2           |

**\*Note:**

- Q1. Identification: ½ mark and reasons: 1½ marks  
Q2. 4 marks for preparation and 1 mark each for identification and drawing  
Q3. Experiment: 2 marks and result: 1 mark

**Semester -V****Core T11 Molecular Biology****4 Credits****Course outcomes:**

The course provides knowledge of basic principles of Molecular Biology including structure and functions of DNA and RNA, DNA Replication, Transcription, Translation, Post Transcriptional Modifications and Processing of Eukaryotic RNA etc.

**Unit 1: Overview of molecular Biology**

Emergence, Historical growth of the discipline and scope

**Unit 2: Nucleic Acids**

Watson and Crick Model of DNA, Structure of t-RNA

**Unit 3: DNA Replication**

Concept of DNA Replication: Semi-conservative, bidirectional, discontinuous, RNA priming, Mechanism of replication in Prokaryotes, Replication of telomeres in Eukaryotes

**Unit 4: Transcription**

Mechanism of Transcription in prokaryotes and eukaryotes, Transcription factors, Difference between prokaryotic and eukaryotic transcription.

**Unit 5: Translation**

Genetic code, Degeneracy of the genetic code and Wobble Hypothesis Mechanism of protein synthesis in prokaryotes, fidelity of protein synthesis, aminoacyl t-RNA synthetase and charging of t-RNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

**Unit 6: Post Transcriptional Modifications and Processing of Eukaryotic RNA**

Capping and Poly-A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing and differential gene expression, RNA editing

**Unit 7: Gene Regulation**

Regulation of Transcription in prokaryotes: lac operon and trp operon;

Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, miRNA mediated gene silencing, Genetic imprinting

**Unit 8: DNA Repair Mechanisms**

Types of DNA repair mechanisms, Rec BCD model in prokaryotes, nucleotide and base excision repair, SOS repair

**Unit 9: Molecular Techniques**

Basic concept of PCR, Western and Southern blot, Northern Blot

**Reference Books**

Albert Bruce, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). Molecular Biology of the Cell, V Edition, Garland publishing Inc., NY and London.

Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. 5th Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman

Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley. Lackie, J.M. (2013). Dictionary of Molecular Biology. 5th Edn. Academic Press.

Lewin, B. (2008). Gene IX. 9th edition, Jones and Barlett. Jones and Bartlett Publishers

Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman

Pal, A. (2011). Textbook of Cell and Molecular Biology 3rd Edn, Books and Allied, Kolkata.

Russel, P.J. (2010). Genetics: A Molecular Approach 3rd edition. Pearson Benjamin

Turner, McLennan, Bales & White (2005). Instant Notes in Molecular Biology. Taylor Francis

Twyman (2002) Advanced Molecular Biology. Viva Publication.

Verma & Agarwal. Cell Biology, Genetics, Molecular Biology, Evolution & Ecology. S. Chand

Watson, Baker, Bell, Gann, Lewin, Losick (2014). Molecular Biology of the Gene. 7th Edn. Pearson.

**Core P11 Molecular Biology Lab****2 Credits****Course outcomes:**

This practical course will enable students to identify Lampbrush chromosome, DNA replication, Transcription as well as preparation of polytene chromosome from *Chironomus* and *Drosophila* larva and preparation of solid culture media (LB) and growth of *E.coli* by spreading and Streaking methods.

**Practicals**

1. Study and interpretation of electron micrograph/photograph showing
  - a. Lampbrush chromosome
  - b. DNA replication
  - c. Transcription
  - d. Split gene
2. Preparation of polytene chromosome from *Chironomus* or *Drosophila* larva
3. Preparation of solid culture media (LB) and growth of *E.coli* by spreading and Streaking methods
4. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern:****Full marks: 15**

- |  |               |
|--|---------------|
| 1. Identification with reasons (any two; From Item no.1) | 5 (2 ½ × 2) * |
| 2. Preparation of polytene chromosome (Item no 2)        | 8 (6+1+1) *   |
| 3. Submission of laboratory note book:                   | 2             |

**\*Note:**

- Q1. Identification: 1 mark and reasons: 1½ marks  
Q2. Preparation: 6 marks and drawing and labelling: 1 mark each

**Core T 12 Principles of Genetics****4 Credits****Course outcomes:**

The course provides knowledge of basic principles of genetics including principles of inheritance, extension of Mendelian genetics, Linkage, Crossing over and Chromosomal Mapping, Mutations, Sex Determination e.t.c.

**Unit 1: Mendelian Genetics and its Extension**

History of Genetics and its scope

Mendel's Theory of inheritance; Incomplete dominance and co-dominance; Epistasis Multiple alleles; Lethal alleles; Pleiotropy; sex-linked, sex-influenced and sex-limited inheritance; Polygenic Inheritance.

**Unit 2: Linkage, Crossing Over and Chromosomal Mapping**

Linkage and Crossing Over; molecular basis of crossing over; Measuring recombination frequency and linkage intensity using three-factor crosses; Interference and coincidence

**Unit 3: Mutations**

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification with one suitable example of each), Non-disjunction and variation in chromosome number; Molecular basis of mutations in relation to UV light and chemical mutagens

**Unit 4: Sex Determination**

1. Mechanisms of sex determination in *Drosophila*, Genic balance theory
2. Sex determination in human
3. Dosage compensation in *Drosophila* & Human
4. Environmental factors (temperature) and sex determination

**Unit 5: Extra-chromosomal Inheritance**

1. Criteria for extra chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*,
2. Kappa particle in *Paramecium*
3. Shell spiralling in snail

**Unit 6: Recombination in Bacteria and Viruses**

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage

**Unit 7: Transposable Genetic Elements**

Transposons in bacteria, Ac-Ds elements in maize, LINE, SINE, Alu elements in humans

**Reference Books**

- Brooker, R.J. (2012). Genetics Analysis and Principles. 4th Edn. McGraw Hill.
- Dale, J.W. and Park, S. F. (2004). Molecular Genetics of Bacteria. 4 th Edn. John Wiley.
- Dudek, E.W. (2013). BRS Genetics. Lippincott, Walker and Wilson
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2010). Introduction to Genetic Analysis WH Freeman.
- Hartl D.L. and Jones, E. W. (1998). Genetics: Principles and Analysis. 4th Edn. Jones and Barlett
- Hartwell, Hood, Goldberg, Reynolds and Sikver (2011). Genetics: From Genes to Genome. 4th Edn. McGraw Hill.
- Hyde, D. (2009). Introduction to Genetic Principle. McGraw Hill.
- Jorde, Carey and Bamshad (2010). Medical Genetics. 4th Edn. Mosby.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition.
- Pierce, B.A. (2013). Genetics Essentials: Concepts and Connections. 2nd Edn. Freeman W.H.
- Russell, P.J. (2009). Genetics-A Molecular Approach. III Edition.
- Scott. F. Gilbert (2010) Developmental biology, 9th edition, Sinauer Associates Inc Snustad, D.P. Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
- Tamarin, R.F (1998). Principles of Genetics. William C Brown Pub
- Verma PS, Agarwal VK (2016). Genetics, 9th edition. S. Chand and Company Pvt. Ltd

**Core P12 Principles of Genetics Lab****2 Credits****Course outcomes:**

This course will enable students to identify the karyotypes of different genetic disorders and analysis of Linkage maps based on *Drosophila* crosses, Pedigree of some human inherited traits and demonstration of techniques of handling *Drosophila*.

**Practicals**

1. Identification of chromosomal aberration in *Drosophila* (inversion, ring chromosome, paracentric inversion) and man (Normal karyotype, Down, Klinefelter's, Turner, Cri-du-Chat syndrome) from photograph
2. Chi-square analyses
3. Linkage maps based on *Drosophila* crosses
4. Pedigree analysis of some human inherited traits
5. Identification of *Drosophila* (wild type and mutant flies) (slide/photograph),
6. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |  |              |
|--|--------------|
| 1. Identification with reasons (any two; From Item no.1 & 5) | 5 (2 ½ × 2)* |
| 2. Any one problem (From Item no. 2 or 3 or 4):              | 8            |
| 3. Submission of laboratory note book:                       | 2            |

**\*Note:**

Q1. Identification: 1 mark for reasons: 1½ marks

**Suggested reading**

1. Banerjee Pranab Kumar (2007) Introduction to Bio-Statistics, 3<sup>rd</sup> Edn, S Chand & Company
2. Banerjee Pranab Kumar (2011) Problems on Genetics Molecular Genetics and Evolutionary Genetics 2<sup>nd</sup> edition, New Central Book Agency

**Semester -VI****Core T-13 Developmental Biology****4 Credits****Course outcomes:**

The course will help students to study fundamentals of animal development including early embryonic development, gametogenesis, Fertilization, development of frog and as well as post embryonic development.

**Unit 1: Introduction**

Basic concepts: Phases of Development, Cell-Cell interaction, Differentiation and growth, Differential gene expression with reference to *Drosophila* pattern formation

**Unit 2: Early Embryonic Development**

Gametogenesis; Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal), prevention of polyspermy; Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers

**Unit 3: Late Embryonic Development**

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in human, Placenta (Structure, types and functions)

**Unit 4: Post Embryonic Development**

Development of brain and Eye in Vertebrate  
Brief idea of regeneration

**Unit 5: Implications of Developmental Biology**

Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Basic concept of Amniocentesis

**Reference Books**

- Carlson, B.M. (2014). Human Embryology and Developmental Biology. 5th Edn. Elsevier.
- Carlson, B.M. (2014). Patten's Embryology. 6th edn, McGraw Hill Education
- Chattopadhyay, S (2018) An introduction to Developmental biology, 1st Ed, Books & Allied
- De Jonge, C.J. and Barratt, CLR (2006). The Sperma cell. Cambridge Univ Press.
- Dudek, R.W. And Fix, J.D. (2013). BRS Embryology. 3rd Edn. Lippincott Williams Wilkins
- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R. and Francis-West, P.H. (2009). Ladesn's Human Embryology. 4th Edn. Elsevier
- Slack JMW (2006). Essential Developmental Biology. 2nd Edn. Blackwell Pub.
- Shostak, S. (1991). Embryology - An Introduction to Developmental Biology. Harper Collins
- Verma and Agarwal. Developmental Biology. S. Chand Pub. New Delhi.
- Rastogi, V.B.; (2012) 1st Ed, Chordate Embryology, Kedar Nath Ram Nath
- Wolpert, L. (2002). Principles of Development. 2nd Edn. Oxford Univ. Press
- Wolpert, L. (2007) Principles of Developmental Biology (3rd edition). Oxford University Press
- UK. Balinsky (2012). Embryology. 5th Ed, Thompson Brooks Cole (India) Pvt. Ltd.

**Core P13 Developmental Biology Lab****2 Credits****Course outcomes:**

The practical course will enable students to identify developmental stages of chick, developmental stages and life cycle of *Drosophila* from stock culture, different sections of placenta and to prepare a project report on *Drosophila* culture/chick embryo development.

**Practicals**

1. Identification of whole mounts of developmental stages of chick through permanent slides: 24, 48 and 72 hours of incubation.
  2. Identification of the developmental stages and life cycle of *Drosophila* from stock culture
  3. Identification of different sections of placenta (epitheliochorial, endotheliochorial and hemochorial) (photomicrograph/ slides)
  4. Project report on *Drosophila* culture /chick embryo development
  5. Submission of Laboratory Note Book
- 

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |  |            |
|--|------------|
| 1. Identification with reasons (any three) (From Item no. 1,2 & 3) | 9 (3× 3) * |
| 2. Project Report (From Item no. 4):                               | 4          |
| 3. Laboratory note book:   | 2          |

**\*Note:**

Q1. Identification: 1 mark and reasons: 2 marks

**Core T 14 Evolutionary Biology****4 Credits****Course outcomes:**

The course will help students to study basic concept of origin of life, Lamarckism, Darwinism and Neo Darwinism, Geological time scale, Fossil records of hominids, Neutral theory of molecular evolution, Molecular clock, Population genetics: Hardy-Weinberg Law, Genetic Drift mechanism etc

**Unit 1**

Basic concept of origin of life, Evolution of life forms and present state of biodiversity

**Unit 2**

Historical review of Evolutionary concepts, Lamarckism, Darwinism and Neo Darwinism

**Unit 3**

1. Geological time scale,
2. Origin and Evolution of Man, comparative account of hominid characteristics and primate characteristics
3. Molecular clock

**Unit 4**

1. Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to bi-allelic Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, types of selection, selection coefficient, mode of selection heterozygous superiority).
2. Genetic Drift mechanism (founder's effect, bottleneck phenomenon)
3. Role of migration and mutation in changing allele frequencies.

**Unit 5**

1. Species concept, Isolating mechanisms, modes of speciation
2. Adaptive radiation, macroevolution (exemplified by Galapagos finches), microevolution

**Unit 6**

Basic concept of extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction

**Unit 7**

Phylogenetic trees, Convergent, Divergent and Parallel evolution.

**Reference Books**

- Barton, N.H., Birggs, D.E.G., Elsen, J.A. Goldstein, D.B. and Patel, N.H. (2007). Evolution. CSHL Press
- Bergstorm, C.T. And Dujatkin, L.A. (2012). Evolution. 1st Edn. W.W. Norton and Co.
- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
- Dobzhansky T., Ayala, F.J., Stebbins, J.L. & Valentine, J.W. (1977). Evolution. Surajeet Pub., N.Delhi
- Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- Freeman, S., Herron, J. C. (2016). Evolutionary Analysis. Pearson Education Limited, Noida, India.
- Gillespie, J.H. (1998). Population Genetics: a Concise Guide. John Hopkins Univ Press.
- Hall, B.K. and Hallgrimson, B. (2008). Stirckberger's Evolution. 4th Edn. Jones and Barlett.
- Kardong, K. (2004). An Introduction to Biological Evolution. McGraw Hill.
- Mitchell, T.N. (2010). Chemical Evolution and the Origin of Life. Springer.
- Page, R.D.M. and Holmes E.C. (1998). Molecular Evolution: A Phylogenetic Approach. Blackwell Sc
- Ridley, M. (1996). Evolution. 2nd Edn. Blackwell Science.
- Russell P.J. (2016) iGenetics: A Molecular Approach. 3rd edition, Pearson Education India Scientific
- American Special Issue (2006). Becoming Human: Evolution and the rise of intelligence.
- Smith, J.M. (1998). Evolutionary Genetics. 2nd Edn. Oxford Univ Press. 15. Volpe, E.P. and Rossenbaum, P.A. (1999). Evolution. McGraw Hill.



**Core P14 Evolutionary Biology Lab****2 Credits****Course outcomes:**

The practical course will enable students to identify major group of fossil, to study of homology and analogy from suitable specimens and verification of Hardy-Weinberg Law by chi square analysis e.t.c

**Practicals**

1. Identification of major group of fossils from models/ pictures (Petrified fossil, molds, casts, carbon film, trace fossil)
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Graphical representation and interpretation of data of height/ weight of a sample of 50 humans in relation to their age and sex.
5. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |  |           |
|--|-----------|
| 1. Identification with reasons (any two) (From Item no. 1 & 2) | 4 (2× 2)* |
| 2. One Problem (From Item no. 3):                              | 5         |
| 3. Project report (From Item no.4)                             | 4         |
| 4. Submission of laboratory note book:                         | 2         |

**\*Note:**

- Q1. Identification: 1 mark and reasons: 1 marks



## 4 Discipline Specific Electives : Syllabus

### DSE T1 : Animal Behaviour and Chronobiology

**4 Credits**

#### Course outcomes:

The course provides knowledge of basic principles of Animal Behavior & Chronobiology including Patterns of Behaviour, Instinct vs. Learned Behaviour, Social and Sexual Behaviour, Altruism, adaptive significance of biological clocks .

#### Unit 1: Introduction to Animal Behaviour

Origin and history of Ethology, Proximate and ultimate causes of behaviour, Methods and recording of a behaviour

Role of behaviour in conservation biology

#### Unit 2: Patterns of Behaviour

Stereotyped Behaviours (Orientation, Reflexes); Individual Behavioural patterns; Instinct vs. Learned Behaviour; Associative learning, classical - and operant conditioning, Habituation, Imprinting.

#### Unit 3: Social and Sexual Behaviour

Social Behaviour: Concept of Society; various modes of animal communication

Altruism; Insects' society with Honey bee as example; Foraging in honey bee and the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

#### Unit 4: Introduction to Chronobiology

Biological oscillation

Adaptive significance of biological clocks

#### Unit 5: Biological Rhythm

Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin and serotonin

#### Reference Books

Alcock John ( 2013) Animal Behaviour, 10<sup>th</sup> Edition, OUP, USA.

Davis, Krebs, West (2012) An introduction to behavioural ecology, Willey Blackwell

Drickamar, Vessey, Jakob (2001), Animal Behaviour , Mc Graw Hill

Jay. C. Dunlap, Jennifer. J. Loros, Patricia J (2004) Chronobiology Biological Timekeeping, De Coursey (ed). Sinauer Associates, Inc. Publishers,

Mandal, F. (2010). A Text Book of Animal Behaviour. Prentice Hall India

Manning and Dawkins (2012) An Introduction to Animal Behaviour, Cambridge University Press

Sherman Paul W. and John Alcock (2005) Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.

Shukla JP (2009) Fundamentals of Animal Behaviour, Atlantic

Sunderland, MA, USA Insect Clocks D.S. Saunders, C.G.H. Steel, X., Afopoulou (ed.) R.D. Lewis. (3rdEd) 2002 Barends and Noble Inc. New York, USA

Vinod Kumar (2002), Biological Rhythms, Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

**DSE PI Animal Behaviour and Chronobiology Lab****2 Credits****Course outcomes:**

This practical course will enable students to study of nests and nesting habits of the birds and social insects, behavioral responses of wood lice to dry and humid conditions, geotaxis behaviour in earthworm, phototaxis behaviour in insect larvae e.t.c.

**Practicals**

1. Study of nests and nesting habits of the birds and social insects.
2. Study of the behavioural responses of any animal (except bird and social insect).
3. Study of geotaxis behaviour in earthworm.
4. Study of the phototaxis behaviour in insect larvae.
5. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
6. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park/ Sea shore to study behavioural activities of animals and prepare a short report
7. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |  |   |
|--|---|
| 1. One experiment (From 3 or 4)                  | 3 |
| 2. Project report (any one from item no. 1 or 2) | 5 |
| 3. Report on excursion (Item 6)                  | 5 |
| 4. Laboratory note book (From 3,4 or 5)          | 2 |

**DSE T2 Biology of Insecta****4 Credits****Course outcomes:**

The will enable students to study Insect Taxonomy, insect classification; general morphology of insects, physiology of insects, photoreceptors structure and function, insect Plant Interaction e.t.c

**Unit 1: Introduction**

General Features of Insects  
Success of Insects on the Earth  
Role of insect in human welfare

**Unit 2: Insect Taxonomy**

Basis of insect classification; Classification of insects up to orders (according to Ruppert and Barnes)

**Unit 3: General Morphology of Insects**

1. External Features; Head - Eyes, Types of antennae, Mouth parts w.r.t. feeding habits
2. Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat ; spiracles and genitalia

**Unit 4: Physiology of Insects**

1. Structure and physiology of Insect - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system
2. Photoreceptors: Types, Structure and Function
3. Types of metamorphosis along with neuroendocrine control

**Unit 5: Insect Society**

1. Social insects with special reference to termites
2. Trophallaxis in social insects such as ants

**Unit 6: Insect Plant Interaction**

Theory of co-evolution; role of allelochemicals in host plant mediation; Host-plant selection by phytophagous insects

**Unit 7: Insects as Vectors**

Brief discussion on Diptera as a carrier of disease and control

**Note: Classification to be followed from IMMS A. D. (1938)**

**Reference Books**

- Bernays, E. A., and Chapman, R. F. ( ) Host Selection by Phytophagous insects, Chapman and Hall, New York, USA  
Borror, D. J., Triplehorn, C. A., and Johnson, N. F. M (1989) Introduction to the study of insects Saunders College Publication, USA  
Chandra G (2000) Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA Mosquito, Sribhumi Pub. Co.  
Chapman, R. F (2012) The Insects: Structure and function, Cambridge University Press,  
UK Gullan P J and Cranston, PS (2000) The Insects, An outline of Entomology, Wiley  
Blackwell, UK Hati A. K (2010) Medical Entomology, Allied Book Agency,  
Imms A D Richards, O.W., Davies, R.G. (1977) Imms' general text book of entomology, Springer  
Netherlands Klowden, M. J (2013) Physiological system in Insects, Academic Press, USA  
Snodgrass, R. E. (2004) Principles of Insect Morphology, Cornell Univ. Press,  
USA Wilson, EO (1971) The Insect Societies, Harvard Univ. Press, UK

**DSE P2 Biology of Insecta Lab****2 Credits****Course Learning Outcomes:**

This practical course will enable students to identify life cycle of Mosquito, different kinds of antennae, legs and mouth parts of insects, mounting of wings, larval spiracles and genitalia of any insects, methodology of collection, preservation of insects and to prepare a Project report.

**Practicals**

1. Identification of life cycle of Mosquito
2. Identification of different kinds of antennae, legs and mouth parts of insects (Cockroach, Praying Mantis, Mosquito)
3. Mounting of wings, larval spiracles and genitalia of any insects (House Fly)
4. Methodology of collection, preservation of insects.
5. Project report: morphological studies of various castes of *Apis sp*, *Camponotus sp*, *Odontotermes sp*
6. Identification of any three major insect pests of paddy (*Scirpophaga*, *Leptocoriza*, and *Hispa* ) and their damages
7. Identification of Mulberry silk moth (life cycle stages)
8. Submission of Laboratory Note Book.

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |  |          |
|--|----------|
| 1. Spot identification with economic importance (any 2; one from each Item no.6 & 7) | 4 (2×2)* |
| 2. Identification with reason (any two, from 1 and 2)                                | 4 (2×2)* |
| 3. Mounting (any one from Item no. 3)  | 2        |
| 4. Project report (any one from Item 5 )   | 3        |
| 5. Submission of laboratory note book:   | 2        |

**\*Note**

- Q 1. 1 mark for identification and 1 mark for economic importance.
- Q2. ½ mark for identification and 1½ mark for reasons.

**DSE T4 Endocrinology****4 Credits****Course outcomes:**

The course will help students to study basic concept of Endocrinology like general idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones, structure of pineal gland, Regulation of Hormone Action, Bioassays of hormones using RIA & ELISA e.t.c.

**Unit 1: Introduction to Endocrinology**

General idea of Endocrine systems, Classification, Characteristic and Transport of Hormones, Neurosecretions and Neurohormones;

**Unit 2: Epiphysis, Hypothalamo-hypophysial Axis**

1. Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.
2. Structure and functions of hypothalamus and Hypothalamic nuclei, Regulation of neuroendocrine glands, Feedback mechanisms
3. Structure of pituitary gland, its hormones and their functions, Hypothalamo-hypophysial portal system, disorders of pituitary gland.

**Unit 3: Peripheral Endocrine Glands**

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

**Unit 4: Regulation of Hormone Action**

1. Mechanism of action of steroidal, non-steroidal hormones with receptors
2. Bioassays of hormones using RIA & ELISA

**Reference Books**

David O Norris (2013) Vertebrate Endocrinology, Elsevier

Fox T., Brooks, A. And Baidya, B. (2015). Endocrinology. JP Medical, London.

Gardner, D.G. And Shoback, D. (2011). Greenspan's Basic and Clinical Endocrinology. 9th Edn. McGraw Hill Lange.

Goodman, H.M. (2000). Basic Medical Endocrinology. 4th Edn. Academic Press. Hall

John E. (2015) Guyton and Hall Textbook of Medical Physiology. 13th Edition

Jameson, J.L. (2010). Harrison's Endocrinology. 2nd Edn. McGraw Hill.

Melmed, Polonsky, Larsen and Kronenberg (2016). William's Text Book of Endocrinology. 13th Edn. Elsevier.

Melmed, S. And Conn, P.M. (2005). Endocrinology: Basic and Clinical Principles. 2nd Edn. Humana Press.

Molina, P.E. (2013). Endocrine Physiology. 4th Edn. McGraw Hill Lange.

Neal, J.M. (2000). Basic Endocrinology; An Interactive Approach. Blackwell Science.

Norris, D.O. (2007). Vertebrate Endocrinology. 4th Edn. Elsevier Academic Press.

Ross & Pawlina (2010) Histology: A Text and Atlas. 6<sup>th</sup> Edition, Lippincott Williams & Wilkins.

Strauss, J.F. and Barbieri, R.L. (2014). Yen & Jaffe's Reproductive Endocrinology. Elsevier Saunders

**DSE P4 Endocrinology Lab****2 Credits****Course outcomes:**

The practical course will enable students to dissect and display of Endocrine glands in laboratory bred rat, identification of all the endocrine glands, Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Testis, Ovary through permanent slides e.t.c.

**Practicals**

1. Dissect and display of Endocrine glands in laboratory bred rat.
2. Identification of all the endocrine glands, Pituitary, Pineal, Thyroid, Parathyroid, Adrenal, Pancreas, Testis, Ovary through permanent slides
3. Tissue fixation, embedding in paraffin, microtomy and slide preparation of any endocrine gland
4. Demonstration of hormone assay through ELISA from teaching Kit
5. Submission of laboratory Note Book

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |  |          |
|--|----------|
| 1. Identification of endocrine gland from dissected specimen (any one, Item 1) | 2*       |
| 2. Identification with reasons (any two) (From Item no.2)                      | 4 (2×2)* |
| 3. Microtomy (Tissue sectioning/staining) (From item 3)                        | 5        |
| 4. Submission of permanent slide (any two mammalian tissue)                    | 2        |
| 5. Submission of laboratory note book:   | 2        |

**\*Note**

- Q1. 1 mark for identification and 1 mark for function  
 Q2. ½ mark for identification and 1½ mark for characters.

**Suggested reading**

Scudamore C.L. (2014). A Practical Guide to the Histology of Mouse. Wiley Blackwell

Brancroft JD, Gamble M (2008) Theory and practice of histological techniques .6th edition, Elsevier Publication

**DSE T3 Fish and Fisheries****4 Credits****Course Outcomes:**

The theory course would fortify the students with in-depth subject knowledge about aquatic organisms as well as marine biology and management of aquatic resources.

**Unit 1: Introduction and Classification**

1. General description of fish, morphometric analysis
2. Feeding habit, habitat and manner of reproduction

**Unit 2: Morphology and Physiology**

Types of fins and their modifications; Locomotion in fish; Hydrodynamics; Types of Scales, Use of scales in Classification and determination of age of fish; Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fish); Electric organ, Bioluminescence

**Unit 3: Fisheries**

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries

**Unit 4: Aquaculture**

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products

**Unit 5: Fish in research**

Zebra fish as a model organism in research  
Transgenic fish

**Note: Classification to be followed from: Romer A. S. (1959)**

**Reference Books**

- Bone Q and R Moore (2008) Biology of Fishes, Talyor and Francis Group, CRC Press,  
U.K.Evans D. H. and J. D. Claiborne (2013) The Physiology of Fishes, CRC Press, UK  
Khanna S.S and H.R. Singh (2017) A text book of Fish Biology and Fisheries, Narendra Publishing House  
Norman J.R (1988) A history of Fishes, Asiatic Publishing House  
Srivastava C.B.L. (1999) Fish Biology, Narendra Publishing House  
Von der Emde, R.J. Mogdans and B.G. Kapoor (2004) The Senses of Fish: Adaptations for the Reception of Natural Stimuli, Springer, Netherlands



**DSE P3 Fish and Fisheries Lab****2 Credits****Course outcomes:**

This practical course will enable them to identify the important fishes present in a lake ecosystem and to determine the amount of Turbidity/transparency, dissolved Oxygen, and Free Carbon dioxide, alkalinity in water collected from a water body.

1. Identification of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera*, *Exocoetus*, *Hippocampus*, *Gambusia*, *Labeo*, *Heteropneustes*, *Anabas*
2. Identification of different types of scales (through permanent slides).
3. Morphometric and meristic characters of fishes
4. Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids
5. Dissect and display of air breathing organs in *Channa*, *Heteropneustes*, *Anabas* and *Clarias*
6. Project Report on a visit to any fish farm/ pisciculture unit/Zebra fish rearing Lab.
7. Submission of Laboratory Note Book.

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |  |           |
|--|-----------|
| 1. Identification with reasons (any three)<br>(two from Item No.1 & one from Item 2) | 6 [2×3] * |
| 2. One dissection from Item 5 or one experiment from Item 4:                         | 3         |
| 3. Project Report  | 4         |
| 4. Submission of laboratory note book:   | 2         |

**\*Note**

Q1. ½ mark for identification and 1½ marks for characters. In case of Item (1) only genus characters have to be mentioned

**Suggested Readings**

Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata

Poddar T.K.S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications

Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books & Allied (P) Ltd

**DSE T3 Parasitology****4 Credits****Course outcomes:**

The course will help students to study basic concept of Parasitism including Parasite, Parasitoid and Vectors, Parasitic Protozoans and to study of *Giardia Intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*, *Schistosoma haematobium*, *Taenia sajinata* as well as morphology, life Cycle..

**Unit 1: Introduction to Parasitology**

Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector) and parasitic disease of human; Host parasite relationship

**Unit 2: Parasitic Protozoans**

Study of *Giardia Intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* : Morphology, Life Cycle, Epidemiology, Pathogenicity, and control.

**Unit 3: Parasitic Platyhelminthes**

Study of *Schistosoma haematobium*, *Taenia sajinata* : Morphology, Life Cycle, Epidemiology, Pathogenicity and control

**Unit 4: Parasitic Nematodes**

Study of *Ancylostoma duodenale*, and *Trichinella spiralis*: Morphology, Life Cycle, Epidemiology, Pathogenicity and control  
Nematode plant interaction; Gall formation

**Unit 5: Parasitic Arthropods**

Biology, importance and control of ticks (Soft tick *Ornithodoros*, Hard tick Ixodes), mites (*Sarcoptes*), Lice (*Pediculus*), Flea (*Xenopsylla*) and Bug (*Cimex*)

**Unit 5: Parasite Vertebrates**

Brief account of vampire ground finch, Vampire bat

**Reference Books**

- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2007) Biology of Disease. Taylor and Francis Group  
Arora, D. R and Arora, B. (2001) Medical Parasitology. II Edition. CBS Publications and Distributors  
Chatterjee K.D. (2009). Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors (P) Ltd.  
Dailey M D. and Schmidt GD (1996) Meyer, Olsen & Schmidt's Essentials of Parasitology, W.C. Brown Publishers  
Mandal FB (2015), Human Parasitology 2nd Edition, PHI Learning  
Noble E.R. and G.A. Noble (1982) Parasitology: The biology of animal parasites. V Edition, Lea & Febiger  
Parija S.C (2013) Textbook of medical parasitology, protozoology & helminthology, 4<sup>th</sup> Edition, All India Publishers & Distributors, New Delhi  
Rattan Lai Ichhpujani and Rajesh Bhatia. (2010) Medical Parasitology, 4<sup>th</sup> Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi

**DSE P3 Parasitology Lab****2 Credits****Course outcomes:**

The practical course will enable students to identify life cycle stages of various parasites including *Giardia* sp., *Trypanosoma* sp., *Leishmania*, *Schistosoma* sp., *Ancylostoma* sp, plant parasitic root knot nematode, *Pediculus* sp, and *Cimex* sp e.t.c.

1. Identification of life cycle stages of *Giardia* sp., *Trypanosoma* sp, *Leishmania* sp through permanent slides/micro photographs
2. Identification of adult and life stages of *Schistosoma* sp, through permanent slides/micro photographs
3. Identification of adult and life stages of *Ancylostoma* sp, through permanent slides/micro photographs
4. Identification of plant parasitic root knot nematode, *Meloidogyne* through permanent slides/micro photographs
5. Identification of *Pediculus* sp, and *Cimex* sp through permanent slides/ photographs
6. Identification of monogenea from the gills of fresh/marine fish [Gills can be procured from fish market]
7. Identification of nematode/cestode parasites from the intestines of fowl
8. Submission of a brief report on any parasite on vertebrates
9. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern****Full marks: 15**

- |   |          |
|---|----------|
| 1. Identification with reasons (any three) (From Item 1,2,3,4,5)              | 6 (2×3)* |
| 2. Temporary preparation of any parasite from gill of fish/ intestine of fowl | 5        |
| [3+1+1]*(From Item 6 or 7)  |          |
| 3. Project Report (Item 8)  | 2        |
| 4. Submission of laboratory note book   | 2        |

**\*Note**

Q1. Maximum 1 from each group. ½ mark for identification and 1½ marks for characters. only genus characters have to be mentioned.

Q2. For dissection 3 marks and 1 mark each for drawing and labelling



## 5. Skill Enhancement Course

**SEC T1 Apiculture****2 Credits****Course outcomes:**

This course of study provides knowledge on biology of bees, Social Organization of Bee Colony, Rearing of Bees, Methods of Extraction of Honey, diseases and enemies as well as Economic importance of Apiculture industry and its uses

**Unit 1: Biology of Bees**

History, Classification and Biology of Honey

Bees Social Organization of Bee Colony

**Unit 2: Rearing of Bees**

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)

**Unit 3: Diseases and Enemies**

Bee Diseases and Enemies

Control and Preventive measures

**Unit 4: Economic Importance**

Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

**Unit 5: Entrepreneurship in Apiculture**

Bee Keeping Industry - Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

**Reference Books**

Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.

Bisht D.S., Apiculture, ICAR Publication.

Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.

**SEC T2 Sericulture****2 Credits****Course outcomes:**

The course will enable students to study the fundamentals of sericulture including rearing of silk worms, biology of silk worms, processing and management of silk industry

**Unit 1: Introduction**

Sericulture: Definition, history and present status: Silk route

Types of silkworms, Distribution and Races

Exotic and indigenous races

Mulberry and non-mulberry Sericulture

**Unit 2: Biology of Silkworm**

Life cycle of *Bombyx mori*

Structure of silk gland and secretion of silk

**Unit 3: Rearing of Silkworms**

Selection of mulberry variety and establishment of mulberry garden]

Rearing house and rearing appliances.

Disinfectants: Formalin, bleaching powder,

Silkworm rearing technology: Early age and Late age rearing

Types of mountages

Spinning, harvesting and storage of cocoons

**Unit 4: Pests and Diseases**

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates

Pathogenesis of silkworm diseases: Protozoan, viral, fungal and

bacterial Control and prevention of pests and diseases

**Unit 5: Entrepreneurship in Sericulture**

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture Visit to various sericulture centres.

**Reference Books**

Manual on Sericulture; Food and Agriculture Organisation, Rome 1976

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

**SEC T3 Aquarium Fish Keeping****2 Credits****Course outcomes:**

The course extends to gain knowledge on Exotic and Endemic species of Aquarium Fishes, Biology of Aquarium Fishes, Food and feeding of Aquarium fishes, Fish Transportation and maintenance of Aquarium.

**Unit 1: Introduction to Aquarium Fish Keeping**

The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

**Unit 2: Biology of Aquarium Fishes**

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angelfish, Blue morph, Anemone fish and Butterfly fish

**Unit 3: Food and feeding of Aquarium fishes**

Use of live fish feed organisms. Preparation and composition of formulated fish feeds, Aquarium fish as larval predator

**Unit 4: Fish Transportation**

Live fish transport - Fish handling, packing and forwarding techniques.

**Unit 5: Maintenance of Aquarium**

General Aquarium maintenance - budget for setting up an Aquarium Fish Farm as a Cottage Industry



## 6. Generic Elective : Syllabus

GE T 1 Animal Diversity

4 Credits

### Course outcomes:

This course is interdisciplinary to have a glimpse of the animal world and includes topics from the simplest protozoan protists to the complex most animals such mammals and all transitory groups of animals.

#### Unit 1: Protozoa

General characters of Protozoa;  
Life cycle of *Plasmodium vivax*

#### Unit 2: Porifera

General characters and canal system in Porifera

#### Unit 3: Cnidaria

General characters of Cnidarians and polymorphism in siphonophorans

#### Unit 4: Aceolomates

General characters of Helminthes

#### Unit 5: Pseudocoelomates

General characters of Nematoda  
Parasitic adaptations

#### Unit 6: Annelida

General characters of Annelida  
Metamerism

#### Unit 7: Arthropoda

General characters  
Social life in insects (Honey Bee)

#### Unit 8: Mollusca

General characters of mollusks  
Pearl Formation

#### Unit 9: Echinodermata

General characters of Echinodermata  
Water Vascular system in Starfish

#### Unit 10: Urochordata and Cephalochordata

Salient features  
Retgressive metamorphosis in *Ascidia*

#### Unit 11: Pisces

General Characters  
Migration of Fish

#### Unit 12: Amphibia

General characters,  
Progressive metamorphosis in Toad,

#### Unit 13: Reptilia

General Characters  
Poisonous and nonpoisonous snakes  
Poison apparatus and biting mechanism in snakes.

**Unit 14: Aves**

General Characters

Flight adaptation in birds

**Unit 15: Mammalia**

General Characters

Dentition in mammals.

**Reference Books**

Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.

Campbell &amp; Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.

Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi.

Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole

**GE P1 Animal Diversity Lab****2 Credits****Course Outcomes:**

The course extends to identify diverse groups of animals by observation and knowing their characteristic features thus provide the students a first-hand knowledge on the subject.

**List of Practical**

1. Identification of following specimens:

a. Non Chordates: *Euglena, Noctiluca, Paramecium, Sycon, Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, Eupagurus, Buthus, Daphnia, Chiton, Dentalium, Octopus, Asterias, and Antedon.*

b. Chordates: *Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Ichthyophis/Uraeotyphlus, Salamander, Rhacophorus, Draco, Uromastix, Naja, Viper, Alcedo, Dinopium, Funambulus, Pteropus.*

2. Identification of following Permanent Slides:

Cross section of *Ascaris* (male and female), T. S. of Earthworm passing through typhlosolar intestine, Bipinnaria and Pluteus larva.

3. Temporary mounts of:

a. Septal nephridia of earthworm.

b. Unstained mounts of placoid, cycloid and ctenoid scales.

4. Dissections : Digestive and nervous system of Cockroach, Afferent branchial arterial system of carp

5. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern**

1. Identification with reasons (any three):

[From Item 1 (any two) and Item 2 (any one)]

2. Dissection (From Item 4)

3. Mounting (any one) (From Item 3):

4. Submission of laboratory note book:

**Full marks: 15**

6 [2×3]\*

5 [3+1+1]\*

2

2

**\*Note**

Q 1. ½ mark for identification and 1½ marks for characters

Q 2. 3 marks for dissection and 1 mark each for drawing and labelling



**GE T2 Aquatic Biology****4 Credits****Course outcomes:**

The interdepartmental course extends knowledge on aquatic organisms in relation to the kinds of aquatic habitats such as fresh water, marine, and management of aquatic resources.

**Unit 1: Aquatic Biomes**

Brief introduction to the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone

**Unit 2: Freshwater Biology**

Lakes: types, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity, dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes (Nitrogen, Sulphur and Phosphorous).

Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

**Unit 3: Marine Biology**

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

**Unit 4: Management of Aquatic Resources**

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

**Reference Books**

Anathakrishnan : Bioresources Ecology 3rd Edition

Goldman : Limnology, 2nd Edition

Odum and Barrett: Fundamentals of Ecology, 5th Edition

Pawlowski: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition Wetzel: Limnology, 3rd edition

Trivedi and Goyal: Chemical and biological methods for water pollution studies Welch: Limnology Vols. I-II

**GE P2 Aquatic Biology Lab****2 Credits****Course Outcomes:**

This practical course will enable them to identify the important zooplanktons present in a lake ecosystem and to determine turbidity/transparency, dissolved Oxygen, and Carbon dioxide, alkalinity in water from different water bodies.

1. Identify the important zooplanktons present in a pond ecosystem.
2. Determine the amount of Dissolved Oxygen, and Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby water body.
3. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.
4. A Project Report on a visit to a Sewage treatment plant/Marine bio- reserve/Fisheries Institute/freshwater ecosystem
5. Submission of Laboratory Note Book

**Distribution of Marks****Examination Pattern**

1. Identification with reasons (any three) [From Item 1 and Item 3]
2. One experiment (pH/ free CO<sub>2</sub>)
3. Project Report (From Item 4):
4. Submission of laboratory note book:

**Full marks: 15**

6 [2×3]\*  
5 [2+3] \*  
2  
2

**\*Note**

- Q 1. ½ mark for identification and 1½ marks for characters
- Q 2. For Principle 2 marks and for result 3 marks

**GE T3 Environment and Public Health****4 Credits****Course outcomes:**

This course provides knowledge on sources of environmental hazards, hazard identification and climate change, pollution as well as waste management technologies.

**Unit 1: Introduction**

Sources of Environmental hazards, Hazard identification and accounting, Fate of toxic and persistent substances in the environment, Dose-response evaluation, Exposure assessment, Persistent organic pollutant

**Unit 2: Climate Change**

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

**Unit 3: Pollution**

Air, water, soil, sound pollution: sources, effects and control,

**Unit 4: Waste Management Technologies**

Sources of waste, types and characteristics, Solid waste disposal, Biomedical waste handling and disposal, e-waste management, 3 R principle of waste management

**Unit 5: Diseases**

Causes, symptoms and control of tuberculosis, Asthma, Cholera, Minamata disease, typhoid,

**Reference Books**

Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.  
Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey, 1997.  
Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. University Press, New York, 2003.  
Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.  
Kolluru Rao, Bartell Steven, Pitblado R and Stricoff "Risk Assessment and Management Handbook", McGraw Hill Inc., New York, 1996.

**GE P3 Environment and Public Health Lab****2 Credits****Course Outcomes:**

The course will enable students to determine pH, Cl<sub>2</sub> SO<sub>4</sub>, NO<sub>3</sub> in soil and water samples from different locations by using soil and water testing kit.

1. Determination of pH, Cl, SO<sub>4</sub>, NO<sub>3</sub> in soil and water samples from different locations by using soil and water testing kit.
2. Project on municipal or medical waste management
3. Submission of laboratory Note Book

**Distribution of Marks****Examination Pattern**

1. One experiment with water sample
2. One experiment with soil sample
3. Project work
4. Submission of laboratory note book

**Full marks: 15**

5 [2+2+1]\*  
5 [2+2+1]\*  
3  
2

**\*Note**

Q 1. and Q2. - 2 marks each for procedure & result and 1 mark for comment

**GE T4 Insect Vectors and Diseases****4 Credits****Course outcomes:**

The course is designed in such a way so that the learners may be able to have the concept of vectors, host-vector relationship, general features of insects as vectors, and study of vector-borne protozoan diseases like Leishmaniasis, Malaria, nematode diseases such as Filarial, viral disease namely, Dengue, Chikungunya.

**Unit 1: Introduction to Insects**

General Features of Insects, Morphological features, Head - Eyes, Types of antennae, Mouth parts

**Unit 2: Concept of Vectors**

Brief introduction to Vectors (mechanical and biological vectors), Reservoir Host, Host-vector relationship, Adaptations as vectors, Host specificity

**Unit 3: Insects as Vectors**

General features of orders with insects as vectors - Diptera, Siphonaptera, Siphunculata, Hemiptera

**Unit 4: Dipteran as Disease Vectors**

1. Mosquitoes, Sand fly, Houseflies
2. Study of mosquito-borne diseases - Malaria, Dengue, Filariasis
3. Study of sand fly-borne diseases -Leishmaniasis
4. Study of house fly as important mechanical vector, Myiasis
5. Control of mosquitoes, Sand fly, house fly

**Unit 5: Siphonaptera as Disease Vectors**

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases - Plague, Typhus fever; Control of fleas

**Unit 6: Siphunculata as Disease Vectors**

Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse

**Unit 7: Hemiptera as Disease Vectors**

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

**Reference Books**

- Chapman, R.F. (1998). The Insects: Structure and Function. IV Edition, Cambridge University Press,  
 UKImms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK  
 Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell  
 Chandra G (2000). Mosquito, Sribhumi Publication Co. Kolkata  
 Hati A. K Medical Entomology, Allied Book Agency, Kolkata  
 Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication

**GE P4 Insect Vectors and Diseases Lab****2 Credits****Course outcomes:**

This course will enable students to identify insect vectors through permanent slides or photographs, mounting of different kinds of mouth parts of insects and study of different diseases transmitted by a insect vectors.

1. Identification of following insect vectors through permanent slides/ photographs: *Aedes*, *Culex*, *Anopheles*, *Pediculus*, *Cimex*, *Phlebotomus*, *Musca* through permanent slides
2. Mounting of different kinds of mouth parts of insects (Mosquito/Cockroach)
3. Submission of a project report on any one of the aforesaid insect vectors and disease transmitted
4. Preparation of laboratory note book

**Distribution of Marks****Examination Pattern**

1. Identification with reasons (any three) [From Item 1]
2. Mounting of mouth parts (From Item 2)
3. Project Report (From Item 4):
4. Laboratory note book:

**Full marks: 15**

9 [3×3]\*  
 2  
 2  
 2

\*Note

Q 1. ½ mark for identification, 1½ marks for characters and 1 mark for name of the disease transmitted