BANKURA UNIVERSITY

(West Bengal Act XIX of 2013- Bankura University Act, 2013)

Main Campus, Bankura Block-II, P.O.: Purandarpur, Dist.: Bankura, Pin- 722155, West Bengal

Office of the Secretary, Faculty Council for Undergraduate Studies

BKU/FCUG/176/2022 Date: 30/08/2022

NOTIFICATION

As directed, the undersigned is pleased to inform you that Bankura University has initiated the process to revise the existing CBCS syllabus of Undergraduate programme in Zoology (Hons.) & Zoology (Programme) and as an important corollary to the process, the workshop through online mode will be organized on the date mentioned herewith to get the feedback from the stakeholders. Present Students, Alumni, Guardians, Academicians and other stakeholders related to the specific programme are requested for their kind participation in the workshop and to present their views/ observations etc. The stakeholders may go through the draft syllabus attached herewith and convey their observations to the office of the undersigned on ugsecretaryoffice@bankurauniv.ac.in within seven days from the date of publication of notice.

Date: 01.09.2022

Time: 06:30 PM (IST)

Link to join: https://meet.google.com/yeq-amjp-ajx

Sd/-
Secretary
Faculty Council for Undergraduate Studies

CBCSSYLLABUS

FOR

THREE YEARS UNDER-GRADUATE COURSE

IN

Zoology (HONOURS)

(*w.e.f. 2022)*

BANKURA UNIVERSITY

BANKURA

WEST BENGAL

PIN 722155

CONTENTS

Introduction

The syllabus for Zoology at undergraduate level using the Choice Based Credit system has been framed in compliance with model syllabus given by 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

		Credits	
Course Type	**Total Papers**	**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
Total	**26**	**140**	**140**

"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			
Total in Semester - I		**22**	**40**	**160**	**200**			

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 2	10	25 15	50			
UG/ZOO H 202/C-4	CT-4: Cell-Biology CP-4: Cell-Biology Lab	4 2	10	25 15	50			
UG/ZOO 203/GE-2	GET : Aquatic Biology GEP: Aquatic Biology Lab	4 2	10	25 15	50			
UG/204/ AECC-2	English/Hind/MIL	2	10	40	50			
Total in Semester - II		**20**	**40**	**160**	**200**			

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 2	10	25 15	50			
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 2	10	25 15	50			
UG/ZOO H/303/C-7	CT-7: Fundamental of Biochemistry CP-7: Fundamental of Biochemistry Lab	4 2	10	25 15	50			
UG/ZOO/ 304/GE-3	GET : Environment and Public Health GEP : Environment and Public Health Lab	4 2	10	25 15	50			
UG/ZOOH/ 305/SEC-1	SECT: Apiculture	2	10	40	50			
Total in Semester - III		**26**	**50**	**200**	**250**			

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 2	10	25 15	50			
UG/ZOOH /402/C-9	CT-9: Animal Physiology: Life Sustaining System CP-9: Animal Physiology: Life Sustaining System Lab	4 2	10	25 15	50			
UG/ZOOH /403/C-10	CT-10: Immunology CP-10: Immunology Lab	4 2	10	25 15	50			
UG/ZOO/ 404/GE-4	GET : Insect Vectors and Diseases GEP : Insect Vectors and Diseases Lab	4 2	10	25 15	50			
UG/ZOOH/ 405/SEC-2	SECT: Sericulture Or Aquarium Fish keeping	2	10	40	50			
Total in Semester – IV		**26**	**50**	**200**	**250**			

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			
Total in Semester – V		**24**	**40**	**160**	**200**			

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			
Total in Semester – VI		**24**	**40**	**160**	**200**			

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 Prc.=Practical

Scheme for CBCS Curriculum in Zoology (Honours)

Semester	Course Name	Course Details	Credits
I	**Ability Enhancement Compulsory Course - I**	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	TBD	4
	Generic Elective - 1 Practical	TBD	2
II	**Ability Enhancement Compulsory Course - II**	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	TBD	4
	Generic Elective - 2 Practical	TBD	2
III	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	TBD	2
	Generic Elective-3	TBD	4
	Generic Elective Practical-3	TBD	2
IV	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	TBD	2
	Generic Elective - 3	TBD	4
	Generic Elective - 3 Practical	TBD	2
V	Core Course-XI Practical	Molecular Biology	4
	Core Course-XII	Principles of Genetics	4
	Core Course-XII Practical	Principles of Genetics Lab	4
	Discipline Specific Elective - 1	TBD	4
	Discipline Specific Elective - 1 Practical	TBD	2
	Discipline Specific Elective – 2	TBD	4
	Discipline Specific Elective - 2 Practical	TBD	2

Scheme for CBCS Curriculum

Semester	Course Name	Course Details	Credits
VI	Core Course-XIII	Developmental Biology	4
	Core Course-XIII Practical	Developmental Biology lab	4
	Core Course-XIV	Evolutionary Biology	4
	Core Course-XIV Practical	Evolutionary Biology Lab	4
	Discipline Specific Elective - 3	TBD	4
	Discipline Specific Elective - 3 Practical	TBD	2
	Discipline Specific Elective - 4	TBD	4
	Discipline Specific Elective - 4 Practical	TBD	2

2.3 Choices for Skill Enhancement Courses (SEC)

Semester	Course	Choice
Sem -III	SEC-1	Apiculture
Sem –IV	SEC-1I	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	GE-1	Animal Diversity
Sem –II	GE-1I	Aquatic Biology
Sem-III	GE--III	Environment and Public Health
Sem –IV	GE-IV	Insect vector and Diseases

2.6 Question pattern for Zoology

For 25 Marks

Sl No.	Questions to be answered	Out of	Marks of each question	Total Marks
1	5	8	1	5 x1=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 x2=10**
2	**4**	**6**	**5**	**4x 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	******	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
Seester -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	X	Sec-2 (Hons)	Aquarium Fish Keeping	SH/ZOO/ 405/SEC-2	2	40	X
	42605	42615	X	Sec-2 (Hons)	Sericulture	SH/ZOO/ 405/SEC-2	2	40	X
	42608	42618	42628	Prog (DSC)	Genetics and evolutionary Biology	SPZOO/ 401/C-1D	6	25	15
	42600	42610	X	Prog (SEC-2)	Aquarium Fish Keeping (Economic Zoology)	SPZOO /404/ SEC-2	2	40	X
Semester -VI	62601	62611	62621	C-13	ZOOLOGY - Developmental Biology	SH/ZOO/601/C-13	4 2	25	15
	62602	62612	62622	C-14	ZOOLOGY - Evolutionary Biology	SH/ZOO/602/C-14	4 2	25	15
	62606	42616	62626	DSE-3	ZOOLOGY - Fish & Fisheries	SH/ZOO/603/DSE-3	4 2	25	15
	62606	42616	62626	DSE-3	ZOOLOGY - Parasitology	SH/ZOO/603/DSE-3	4 2	25	15
	62607	42617	62627	DSE-4	ZOOLOGY - 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
Sem-I	C 1- Non Chordate 1 C 2- Ecology	GE1- Animal Diversity	********	********	Environmental Studies
Sem-II	C 3- Non Chordate II C 4- Cell Biology	GE2- Aquatic Biology	********	********	English / MIL
Sem-III	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	********
Sem-IV	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	********
Sem-V	C 11- Molecular Biology C 12- Principles of Genetics	********	DSE 1—Animal Behaviour and Chronobiology DSE 2—Biology of Insecta	********	********
Sem-VI	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 a student should be able to:-

P O	Program Outcome	Description
PO. 1	Sound domain knowledge in different fields of Zoology	Students pass out this programme become adept in hands-on activities. Students get conversant with different recent trends of scientific works happening in and around. Students are expected to learn the fundamental concepts, principles and processes underlying the academic field of Zoology and its different subfields (animal diversity, principles of ecology, comparative anatomy and developmental biology of vertebrates, physiology and biochemistry, genetics and evolutionary biology, animal biotechnology, applied Zoology, aquatic biology, immunology, reproductive biology, and insect, vectors and diseases, apiculture, aquarium fish keeping, medical diagnostics, and sericulture
PO. 2	Professional skills developd in the field of Zoology	To develop the basics of professional skills in the field of Zoology and related fields such as, apiculture, aquarium fish keeping, medical diagnostics, and sericulture as well as skills related to specialization areas within Zoology as well as within subfields of Zoology, including broader interdisciplinary subfields (Chemistry, Physics and Mathematics).
PO. 3	Academic and scientific endeavor	The student will be able to find differences within the same breed of an animal species and will develop fundamental knowledge in Ornithology, Herpetology, Arachnology, and other related branches of animal science.
PO. 4:	Environmental awareness	They will be able to explain the complexity of life processes and their molecular, cellular and physiological basis, their genetics, evolution and behaviour and their interrelationships with the environment
PO. 5	design and conduct experiments to test a hypothesis	The programme will fortify the students to design and conduct experiments to test a hypothesis, to understand and interpret data to reach a conclusion as well as to understand the scientific principles underlying animal health, management and welfare.
PO. 6	Job opportunity	To help the students for development of essential academic skills like critical thinking, analytical reasoning, research skills, teamwork, basic laboratory and analytical skills, use of effective methods, participating in various programmes, statistical analysis of data gained from experiments, citing & referencing work appropriately e.t.c.

2.11Programme Specific Outcomes (PSO)

- The core courses would fortify the student's opportunity to develop a knowledge and understanding of living organisms at several levels of zoological and biological organization from the molecular, through to cells and whole organisms and ecosystems; all from an evolutionary perspective with in-depth subject knowledge concurrently.

- The discipline specific electives will add additional knowledge about applied aspects of the program as well as its applicability in both academia and industry.

- The skill enhancement courses would further add additional skills related to the subject as well as other subjects.

- Students become highly cognizant of the expansion of the learning in their respective field which enables them to get admitted to the premier institutes of the country. An aptitude to research is also stimulated in the minds of this budding generation which prompts them to take up some projects in good laboratories of the country after completing the programme

- Students ripen their investigative proficiency so that they can open up the entrances of the future knowledge world.

- 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.

- Students will be able to make solutions of biological problems by experimentation and subsequent data processing by modern technologies and computer applications. Students will be able to analyze and solve the problems related to animal sciences without relying on assumptions and guesses

- Students will be able to make solutions of biological problems by experimentation and subsequent data processing by modern technologies and computer applications. The programme will fortify the students to develop fundamental knowledge in biodiversity and their conservation, pollution of environment and their control measures.

- They will 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.

- 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 behavior. Research Motivation is also another significant outcome that the students are endowed with on the completion of the programme

- 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.

3. Core Subjects Syllabus

Semester- I

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

Non-chordates I: Protista to Pseudocoelomates

Course Learning Outcomes:

The courses would fortify the students to gain knowledge and skill in the fundamental principles of Taxonomy, Systematics and some Invertebrate phylum (Protozoa to Nematoda) and will understand the basic biology and complex interactions among various living organisms.

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

General characteristics and classification up to classes (Hyman)

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 1994,6th Edition

Reference Books

Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks ColeBrusca, 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 PI - Non-Chordates I Lab 2 credits

Core PI - Non-Chordates I Lab

Course Learning Outcomes:

This practical course will enable them to be familiarized with a wide range of Invertebrate fauna and will help them to learn their salient features and some basic structural organization with taxonomic details.

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 *Paramoecium.*

3. Staining and mounting of any protozoa/helminth from gut of cockroach.

4. Submission of Laboratory Note Book

Distribution of Marks:

Full marks: 15

1. Identification with reasons (any three): 9 [3×3]

(From Item No. 1; maximum one from each group)

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: I mark, labelling: 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

Perspectives in Ecology

Course Learning Outcomes:
The course considers a diverse range of chapters of ecological knowledge, through which students will be able to gather information on the fundamental concepts like energy flow in ecosystem, niche concept, community ecology, population ecology, prey predator interaction as well as some aspects of applied ecology.

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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
Bio DiversityWildlife Conservation (in-situ and ex-situ conservation)
Management strategies for tiger conservation; Wild life protection act (1972)

Unit 6: Biometryurement
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, Concpts, Application. 2nd Ed. Springer Science and Business Media.

Core P2 - Perspectives in Ecology Lab 2 Credits

Core P2 - Perspectives in Ecology Lab

Course Learning Outcomes:

This laboratory course provides knowledge about the quantitative measurement of biodiversity in a community as well as help them to learn about the techniques for qualitative parameter measurement in an aquatic ecosystem. Futher, the students get a chance to visit a biodiversity rich land (National Park/Biodiversity Park/Wild life sanctuary) to enrich their knowledge.

Practicals

1. Determination of population density in a natural/hypothetical community by quadrate 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_2

3. Report on a visit to Zoological Park/National Park/Biodiversity Park/Wild life sanctuary

4. Submission of Laboratory Note Book

Distribution of Marks:

	Full marks: 15
1. Experiment (from Item no. 1):	5
2. Experiment (from Item no. 2; pH or free O_2 or free CO_2 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 Cummings

Darrell 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

Core T3 - Non-Chordates II | **Semester- II** | **4 Credits**

Non-Chordates II: Coelomates

Course Learning Outcomes:

The course enables the students to develop knowledge on General characteristics, classification, evolutionary significance of several Invertebrate phylums (Annelida to Echinodermata) and their basic structural organization.

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 1994,6th Edition

Reference Books

Anderson, D. T. (Ed.) (2001). Invertebrate Zoology. 2nd Ed. Oxford University Press.
Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. 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 Lab 2 Credits

Non-Chordates II: Coelomates Lab

Course Learning Outcomes:

The courses would fortify the students with in-depth subject knowledge about the identification of a wide range of Invertebrate specimens as well as life cycle stages of insects and dissection, drawing and labelling of different systems.

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

Full marks: 15

1. Identification with reasons (any three): (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

Cell Biology

Course Learning Outcomes:

The course considers a diverse range of chapters of cell biology through which students will learn about fundamentals of cell structure and function, cytoplasmic organelles like Mitochondria, Endoplasmic Reticulum, Ribosome, Golgi Apparatus, Lysosomes as well as the basic principles of cell signalling, receptors, cell cycle, apoptosis and cancer.

Unit 1: Overview of Cell

Basic concepts of Prokaryotic and Eukaryotic cell

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, Inhibitors and un-couplers of Electron Transport System
3. Peroxisomes: Structure and Functions
4. 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 MolecularApproach.5thEdition. 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 3rdEdition–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. 2ndedition. Garland Science, Taylor and Francis

Core P4 - Cell Biology Lab 2 Credit

Cell Biology Lab

Course Learning Outcomes:
his practical course will enable them to be familiarized with the student's light microscope and stereo-binocular microscope, preparation of various stains, preparation and identification of various stages of mitosis and meiosis as well as permanent slides of Barr body from 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	**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 & Allied (P) Ltd

Core T5 - Diversity of Chordata | Semester -III | 4 Credits

Diversity of Chordata

Course Learning Outcomes:

The course would strengthen the students with in-depth subject knowledge in general characteristics and classification of Chordata as well as some special events or structures of chordate life like metamorphosis and parental care in Amphibia, poison apparatus and biting mechanism in snakes, principles and aerodynamics of flight

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 Hallgrimsson 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

Diversity of Chordata Lab

Course Learning Outcomes:

This practical course will enable students to identify a large number of chordate specimens from Cephalochordata to Mammalia and will help them 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, Tylototriton*,
   e. *Chelone, Hemidactylus, Uromastix, Chamaeleon, Ophiosaurus, 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

Full marks: 15

1. Identification with reasons (any three):	9 [3×3]
(From Item no. 1; maximum 1 from each group)	
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

Animal Physiology: Controlling & Coordinating Systems

Course Learning Outcomes:

This core course will provide the students better understanding of the basics of animal physiology including the structure and functions of epithelial, connective, muscular and nervous tissue, histology of reproductive System as well as basic concept of the endocrine system and the mechanism of hormone action.

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, Jensh Ronald (2002) Bloom & Fawcett's Concise Histology 2nd Edition, CRC Press;

Gunasegaran, JP (2010). A Text book of Histology and a Practical Guide. Elsevier

Junqueria 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

Animal Physiology: Controlling & Coordinating Systems Lab

Course Learning Outcomes:

This practical course will fortify the students with in-depth practical skills in microtomy, slide preparation of mammalian tissue, recording of simple muscle twitch by Kymograph as well as identification of histological slides of various Mammalian tissue section.

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

	Full marks: 15	
1. Identification with reasons (any two; From Item no. 1):	6	[3+3]
2. Peparation (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 Blackwell

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

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

Core T7 - Fundamentals of Biochemistry 4 Credits

Fundamentals of Biochemistry

Course Learning Outcomes:

Fundamentals of Biochemistry course provides knowledge of basic principles and mechanism of biochemistry including structure and importance of biological macromolecules like carbohydrates, protein, lipid, nucleic acid as well as the basic understanding of enzyme function, kinetics and oxidative phosphorylation in mitochondrial matrix.

Unit 1: Introduction to biochemistry and its scope

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: β-oxidation of fatty acids (saturated and unsaturated)

Unit 4: Proteins

1. Amino acids: Structure, classification, General -and Electro chemical properties of α-amino acids; Physiological importance of essential andnon-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, 31st 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

Fundamentals of Biochemistry Lab

Course Learning Outcomes:

This practical course on Biochemistry will enable students to learn a number of experimental techniques like qualitative test of functional groups in biological macromolecules, quantitative estimation of protein, basic principles of paper chromatography of amino acid 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

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

Comparative Anatomy of Vertebrates

Course Learning Outcomes:
The course would strengthen the students with in-depth subject knowledge in comparative anatomy of Vertebrate Integumentary System, Structure, Skeletal System, Digestive System, Respiratory System, Circulatory System .

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. 3rd 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

Comparative Anatomy of Vertebrates Lab

Course Learning Outcomes:

This practical course will enable students to identify disarticulated skeleton, skull and vertebrae of Toad, Pigeon and Guineapig, carapace and plastron of turtle, to learn about staining and mounting of placoid, cycloid and ctenoid scales to develop basic skill in Vertebrate dissection.

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

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

Animal Physiology: Life Sustaining Systems

Course Learning Outcomes:

The course will enable students to learn about basic principles Animal Physiology including physiology of digestion, respiration, circulation, heart .

Unit 1: Concept of life sustainence

Unit 2: Physiology of Digestion
Structural organisation 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. Hercourt 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 and 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.

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

Animal Physiology: Life Sustaining Systems Lab

Course Learning Outcomes:

This practical course will enable students to enumerate the red blood cells and white blood cells using haemocytometer, estimation of haemoglobin using Sahli's haemoglobinometer, determination of ABO Blood group, preparation of haemin crystals and recording of blood pressure using a sphygmomanomer.

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 T 10 Immunology 4 Credits

Immunology

Course Learning Outcomes:

This course on Immunology will allow students to learn about basic principles innate and adaptive Immunity, Antigenicity and immunogenicity, Immunoglobulins, Immunoassays, Major Histocompatibility Complex, Cytokines, Complement System .

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), Hybridoma technology, 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 9. Virella, G (2007). Medical Immunology 6th Edn. Informa Healthcare

Core P10 Immunology Lab 2 Credits

Immunology Lab

Course Learning Outcomes:

This practical course will enable students to identify lymphoid organs of human, histological slides: T.S 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

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

Distribution of Marks

	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**

Molecular Biology

Course Learning 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 .

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, amino acyl t RNA synthetases and charging of tRNA; 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 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, Joned 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 P ll - Molecular Biology Lab 2 Credits

Molecular Biology Lab

Course Learning 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

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

Principles of Genetics

Course Learning 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

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 *Paramoecium*
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. Lippincoat, 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, Reynolls 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. Benjamin Cummings
Pierce, B.A. (2013). Genetics Essentials: Concepts abd Connections. 2nd Edn. Freeman W.H.
Russell, P.J. (2009).Genetics-A Molecular Approach. III Edition. Benjamin Cummings
Scott. F. Gilbert (2010) Developmental biology, 9th edition, Sinauer Associates Inc
Snustad, D.P.Simmons,M.J.(2009).PrinciplesofGenetics.VEdition.JohnWileyandSonsInc
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

Principles of Genetics Lab

Course Learning Outcomes:

This practical 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 Drosoph.

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

	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, 3rd Edn, S Chand & Company
2. Banerjee Pranab Kumar (2011) Problems on Genetics Molecular Genetics and Evolutionary Genetics 2nd edition, New Central Book Agency

Core T-13 Developmental Biology

Semester -VI

4 Credits

Developmental Biology

Course Learning 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

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. Elsvier.

Carlson, B.M. (2014). Patten's Embryology. 6th edn, McGraw Hill Education

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. Lippincoat Williams Wilkins

Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA Slack JMW , Essential Developmental Biology

Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R. and Francis-West, P.H. (2009). Ladesn's Human Embryology. 4th Edn. Elsvier

Slack JMW (2006). Essential Developmental Biology. 2nd Edn. Blackwell Pub.

Verma and Agarwal. Developmental Biology. S. Chand Pub. New Delhi.

Wolpert, L. (2002). Principles of Development. 2nd Edn. Oxford Univ. Press

Core P13 Developmental Biology Lab 2 Credits

Developmental Biology Lab

Course Learning 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

	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

Evolutionary Biology

Course Learning Outcomes:

The course will help students to study basic concept of origin of life,Lamarkism, 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 .

Unit 1
Basic concept of origin of life, Evolution of life forms and present state of biodiversity

Unit 2
Historical review of Evolutionary concepts, Lamarkism, 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
Species concept, Isolating mechanisms, modes of speciation
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) iGeneics: 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 P 14 Evolutionary Biology Lab 2 Credits

Evolutionary Biology Lab

Course Learning 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 .

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

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 Subjects Syllabus

DSE T1 - Animal Behaviour and Chronobiology 4 Credits

Animal Behaviour and Chronobiology

Course Learning 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, 10th 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 Barens 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

Animal Behaviour and Chronobiology Lab

Course Learning Outcomes:

This practical course will enable students to study of nests and nesting habits of the birds and social insects, behavioural 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 wood lice to dry and humid conditions.
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

	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

Biology of Insecta

Course Learning Outcomes:

The Biology of Insecta course 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, Harward Univ. Press, UK

DSE P2 Biology of Insecta Lab 2 Credits

Biology of Insecta Lab

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

	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 T3 – Endocrinology 4 Credits

Endocrinology

Course Learning 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 .

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. 6th Edition, Lippincott Williams & Wilkins.

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

DSE P3 Endocrinology Lab 2 Credits

Endocrinology Lab

Course Learning 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

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

	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 T4 - Fish and Fisheries 4 Credits

Fish and Fisheries

Course Learning Outcomes:

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 ofage 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
Transgenic fish
Zebrafish as a model organism in research

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 P4 - Fish and Fisheries Lab 2 Credits

Fish and Fisheries Lab

Course Learning Outcomes:

Practicals

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/Zebrafish rearing Lab.
7. Submission of Laboratory Note Book.

Distribution of Marks

	Full marks: 15
1. Identification with reasons (any three)	
(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 T5 Parasitology 4 Credits

Parasitology

Course Learning 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* 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 t h Edition, All India Publishers & Distributers, New Delhi

Rattan Lai Ichhpujani and Rajesh Bhatia. (2010) Medical Parasitology, 4th Edition, Jaypee Brothers Medical Publishers (P) Ltd., New Delhi

DSE P5 Parasitology Lab 2 Credits

Parasitology Lab

Course Learning 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.

List of Practicals

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

	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 (From Item 6 or 7)	5 [3+1+1]*
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

Apiculture

Course Learning Outcomes:

This Apiculture course 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, NewDelhi.

SEC T2 Sericulture 2 Credits

Sericulture

Course Learning Outcomes:

The course will enable students to study the fundamentals of sericulture including rearing of silk worms, biology of silk worms, processing amd 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, RKO
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, Japan1972.

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

Aquarium Fish Keeping

Course Learning Outcomes:

The course provides in-depth subject knowledge in Aquarium Fish Keeping including 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, Angel fish, 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

GE T1- Animal Diversity 4 Credits

Animal Diversity

Course Learning Outcomes:

The course considers a diverse range of chapters of Animal Diversity, through which students will be able to gather information on a wide range of fauna and will help them to learn their salient features and some basic structural organization with taxonomic details.

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 mollusc

Pearl Formation

Unit 9: Echinodermata

General characters of Echinodermata

Water Vascular system in Starfish

Unit 10: Urochordata and Cephalochordata

Salient features

Retrogressive 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 snake

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 & 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

Animal Diversity Lab

Course Learning Outcomes:

This practical course will enable them to be familiarized with a wide range of Invertebrate and Vertebrate fauna and will help them to learn their salient features and some basic structural organization with taxonomic details.

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, Icthyophis/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

Full marks: 15

1. Identification with reasons (any three):	6 [2×3]*
[From Item 1 (any two) and Item 2 (any one)]	
2. Dissection (From Item 4)	5 [3+1+1]*
3. Mounting (any one) (From Item 3):	2
4. Submission of laboratory note book:	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

Aquatic Biology

Course Learning 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: 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

Aquatic Biology Lab

Course Learning Outcomes:

This practical course will enable them to identify the important zooplanktons 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.

List of Practical

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

	Full marks: 15
1. Identification with reasons (any three) [From Item 1 and Item 3]	6 [2×3]*
2. One experiment (pH/ free CO_2)	5 [2+3] *
3. Project Report (From Item 4):	2
4. Submission of laboratory note book:	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

Environment and Public Health

Course Learning Outcomes:

This course provides knowledge on sources of environmental hazards, hazard identification and accounting, 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 anddisposal, 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

Environment and Public Health Lab

Course Learning Outcomes:

This practical course will enable students to determine pH, Cl, SO4, NO3 in soil and water samples from different locations by using soil and water testing kit.

List of Practical

1. To determine pH, Cl, SO_4, NO_3 in soil and water samples from different locations by using soil and water testing kit.
2. Submission of laboratory Note Book

Examination Pattern:	**Full marks: 15**
1. One experiment with water sample	6 [2+2+2]*
2. One experiment with soil sample	7 [2+3+2]*
3. Submission of laboratory note book:	2

***Note**

Q 1. 2 marks each for procedure, result and comment

Q 2. 3 marks for procedure and 2 marks each for result and comment

GE T4 - Insect Vectors and Diseases 4 Credits

Insect Vectors and Diseases

Course Learning Outcomes:

The course would strengthen the students with in-depth subject knowledge in Concept of Vectors, host-vector relationship, general features of insects as vectors, disease vectors and study of vector-borne diseases like Malaria, Dengue, Chikungunya, Filariasis, Leishmaniasis e.t.c.

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: Hempitera 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, UK

Imms, 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 Mosquito (2000) Chandra G, Sribhumi Publication Co. Kolkata Medical Entomology, Hati A. K Allied Book Agency, Kolkata

Pedigo L.P. (2002). Entomology and Pest Management. Prentice Hall Publication

GE P4 - Insect Vectors and Diseases Lab 2 Credits

Insect Vectors and Diseases Lab

Course Learning Outcomes:

This practical 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 above insect vectors.

List of Practical

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

	Full marks: 15
1. Identification with reasons (any three) [From Item 1]	9 [3×3]*
2. Mounting of mouth parts (From Item 2)	2
3. Project Report (From Item 4):	2
4. Laboratory note book:	2

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

REVISED CBCS SYLLABUS

FOR

THREE YEARS UNDER-GRADUATE COURSE

IN

B.Sc General Degree Course (*w.e.f. 2022*)

BANKURA UNIVERSITY

BANKURA

WEST BENGAL

PIN 722155

MODEL STRUCTURE IN B.Sc General Degree Course

SEMESTER – I

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UGP/SC/101/C-1A	**Animal Diversity**	6	10	40	50		25	15
UGP/102/ C-2A	Discipline-2	6	10	40	50			
UGP/103/ C-3A	Discipline-3	6	10	40	50			
UG/ 104/ AECC-ENV	Environmental Studies	4	10	40	50			
Total in Semester - I		**22**	**40**	**160**	**200**			

SEMESTER –II

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UGP/S.C./201/ C-1B	**Comparative anatomy and Developmental Biology of Vertebrate**	6	10	40	50		25	15
UGP/202/ C-2B	Discipline - 2	6	10	40	50			
UGP/ 203/C-3B	Discipline - 3	6	10	40	50			
UG/204/ AECC-E/MIL	English/MIL	2	10	40	50			
Total in Semester - II		**20**	**40**	**160**	**200**			

SEMESTER – III

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UGP/S.C./ 301/C-1C	**Physiology and Biochemistry**	6	10	40	50		25	15
UGP/302/C-2C	Discipline - 2	6	10	40	50			
UGP/ 303/ C-3C	Discipline - 3	6	10	40	50			
UGP/S.C/304/ SEC-1	Apiculture (Economic Zoology)	2	10	40	50			
Total in Semester - III		**20**	**40**	**160**	**200**			

SEMESTER – IV

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UGP/S.C./401/ C-1D	**Genetics and Evolutionary Biology**	6	10	40	50		25	15
UGP/ 402/ C-2D	Discipline-2	6	10	40	50			
UGP/ 403/ C-3D	Discipline-3	6	10	40	50			
UGP/S.C./404/ SEC-2	**Aquarium Fish Keeping** (Economic Zoology)	2	10	40	50			
Total in Semester - IV		**20**	**40**	**160**	**200**			

SEMESTER – V

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UGP/S.C./501/ DSE-1A	**DSET 1a Applied Zoology Or 1b Insect vector and Disease DSEP 1a Applied Zoology Lab Or 1b Insect vector and Disease**	6	10	40	50		25	15
UGP/ 502/DSE-2A	Discipline - 2	6	10	40	50			
UGP/ 503/DSE-3A	Discipline - 3	6	10	40	50			
UGP/S.C./504/ SEC-3	**Sericulture** (Economic Zoology)	2	10	40	50			
Total in Semester – V		**20**	**40**	**160**	**200**			

SEMESTER – VI

Course Code	Course Title	Credit	Marks			No. of Hours		
			I.A.	ESE	Total	Lec.	Tu.	Pr.
UGP/S.C. / 601/DSE-1B	**DSET 2a Aquatic biology Or 2b Immunology DSEP 2a Aquatic biology Lab Or 2b Immunology Lab**	6	10	40	50		25	15
UGP/ 602/DSE-2B	Discipline - 2	6	10	40	50			
UGP/ 603/DSE-3B	Discipline - 3	6	10	40	50			
UGP/S.C./ 604/SEC-4	**Medical Techniques**	2	10	40	50			
Total in Semester – VI		**20**	**40**	**160**	**200**			

UGP= Under Graduate programme/Pass, S.C.= Subject Code C= Core Course, E/H/MIL= English/ Hindi/ Modern Indian Language, H/MIL/E= Hindi/ Modern Indian Language/ English, AECC-E= Ability Enhancement Compulsory Course- English, AECC-ENV= Ability Enhancement Compulsory Course-Environmental Science, 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

CBCS Undergraduate Program in Zoology General

Course Type	Number of Courses	Credits		
		Theory	Practical	Theory + Practical
Core course (CC)	12 Papers (Four Papers each in 3 Disciplines of Choice)	4 X12=48	2 X12	72
Discipline Specific Elective Subject(DSE)	6 Papers (Two Papers each in 3 Disciplines of Choice	4 X06=24	2 X16=12	36
Ability Enhancement Compulsory Course (AECC)	2 Papers (Compulsary Language Paper & Environmental Syudies	4 X 1=4 2 X 1=2		6
Skill Enhancement Course (SEC)	4 Papers	4 X2=8		8
Total		86	36	122

CORE COURSES

CC-1A Animal Diversity
CC-1B Comparative Anatomy and Developmental Biology of Vertebrates
CC -1C Physiology and Biochemistry
CC-1D Genetics and Evolutionary Biology

DISCIPLINE SPECIFIC ELECTIVE COURSES (DSE)

DSE 1a: Applied Zoology Or 1b Insect Vector and Disease
DSE 2a : Aquatic Biology or 2b :Immunology

SKILL ENHANCEMENT COURSES: ZOOLOGY

SEC 1: Apiculture

SEC 2: Aquarium Fish Keeping

SEC 3: Sericulture

SEC 4: Medical Techniques

3. Core Subjects Syllabus

3.1 Core T1 - Animal Diversity

Animal Diversity **4 Credits**

Theory

Unit-1 Sub- Kingdom Protozoa
1. General characters and classification of Subkingdom Protozoa up to Phylum (Levine et al., 1980);
2. Locomotory Organelles and locomotion in Protozoa (Pseudopodia, Cilia, Flagella)

Unit-2 Phylum Porifera
1. General characters and classification up to classes (Hyman);
2. Canal System in *Sycon*

Unit-3 Phylum Cnidaria
1. General characters and classification up to classes;
2. Polymorphism in *Siphonophora*

Unit-4 Phylum Platyhelminthes
1. General characters and classification up to classes;
2. Life history of *Taenia solium*

Unit-5 Phylum Nematoda
1. General characters and classification up to classes;
2. Life history of *Ascaris lumbricoides*

Unit-6 Phylum Annelida
1. General characters and classification up to classes;
2. Nephridia in annelids

Unit 7 Phylum Arthropoda
1. General characters and classification up to classes;,
2. Metamorphosis in insects

Unit-8 Phylum Mollusca
1. General characters and classification up to classes;
2. Torsion in gastropods.

Unit-9 Phylum Echinodermata
1. General characters and classification up to classes;
2. Water-vascular system in *Asterias*

Unit-10 P h y l u m **Hemichordata**
1. General features;
2. Affinities of *Balanoglossus*.

Unit-11 P h y l u m **Urochordata**
1. General f eatures
2. Retrogressive metamorphosis in Ascidia

Unit-12 Phylum **Cephalochordata**
1. General features;
2. Filter feeding in *Branchiostoma*

Unit-13 S e r i e s **Pisces**
1.General features and Classification up to Subclasses (Romer, 1959);
2. Osmoregulation in fishes

Unit-14 Clasas Amphibia
1. General features and Classification up to living orders (Nobel 1924);
2. Metamorphosis in Toad

Unit-14 Class **Reptilia**
1. General features and Classification up to living Subclass (Young, 1981);
2. Poisonous and non-poisonous snakes,

Unit-15 C l a s s **Aves**
1. General features and Classification up to orders (Young, 1981);
2. Volant adaptations in birds

Unit-16 C l a s s **Mammalia**
1. Classification up to Subclasses (Young, 1981);
2. Dentition in mammals

Note:

Classification of Unit 3-9 to be followed from —Ruppert & Barnes, (1994), Invertebrate Zoology, VI Edition

Suggested Readings [Consult Latest Editions]

1. Arora, M.P.*Chordata I. Himalaya Pub House*
2. Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6thEd. Brooks Cole.
3. Chatterjee, A & Chakraborty C.S. Approach to a Text Book of Zoology Nirmala Library, Kolkata.
4. Dhami P.S and J.K. Dhami – Invertebrate Zoology – S. Chand and Co.
5. Jordan, E. L. & Verma, P. S. (2006). Invertebrate Zoology & Chordate Zoology.. S. Chand & Company Ltd. New Delhi.
6. Kotpal, R.L., 1988 – 1992. (All Series) Protozoa, Porifera, Coelentereta, Annelida, Arthropoda, Mollusca, Echinodermata, – Rastogi Publications, Meerut – 250 002.
7. Romer, A.S. & Parsons,T.S.(1986).The vertebrate body. 6thEd. Saunders College Pub.
8. Ruppert E. E., Fox, R. & Barnes R. D. (2003). Invertebrate Zoology: a Functional Evolutionary Approach. 7th Ed. Brooks Cole.

3.2 Core P1 Animal Diversity

Animal Diversity Lab **2 Credits**

Practicals

1. Spot identification of the following specimens (Nonchordates):

Amoeba, Euglena, Paramecium, Sycon, Euspongia, Obelia, Physalia, Aurelia, Tubipora, , Taenia, Ascaris, Aphrodite, Nereis, Pheretima,, Palaemon, Limulus, Scolopendra, Julus,, Chiton, Dentalium, Unio, Loligo, Ophiura, Echinus, Cucumaria, Balanoglossus,

2. Spot identification of the following specimens (Chordates):

Branchiostoma, Petromyzon, Torpedo, Labeo, Exocoetus, Ichthyophis,Salamandra, Hyla, Chelone, Chamaeleon, Draco, Naja, Passer, Alcedo, Pteropus, Funambulus, Bandicota

3. Submission of a Project Report on 'animal album" containing photographs, cut outs, with appropriate write up about any above mentioned taxa/ Different taxa/ topics may be given to different sets of students for this purpose

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

1.Spot identification (6 from Item 1and 2; 3 each from non-chordate & chordate)	(6 × 1 ½) = 09
2.Submission of a project report	= 04
3.Submission of laboratory note book:	= 02

Note: Q1. For Item (1), ½ mark for Sc. name and 1 mark for systematic position

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

3.3 Core T2 - Comparative anatomy and Developmental Biology of Vertebrate

Comparative anatomy and Developmental Biology of Vertebrate **4 Credits**

Theory

Unit 1: Integumentary System
Derivatives of integument with reference to Scales in fishes, feathers in Bird, Horn & Antlers in mammals

Unit 2: Skeletal System
Evolution of visceral arches

Unit 3: Digestive System
Brief account of alimentary canal and digestive glands

Unit 4: Respiratory System
Brief account of Gills, lung and, air sacs

Unit 5: Circulatory System
Evolution of heart and aortic arches

Unit 6: Urinogenital System
Evolution of Kidney (Pro, meso, meta)

Unit 7: Nervous System
Comparative account of brain

Unit 8: Sense Organs
Types of receptors

Unit 9: Early Embryonic Development
Spermatogenesis and oogenesis with reference to mammals, Fertilization: external (amphibians), internal (mammals), patterns of cleavage, fate map, and gastrulation in frog embryo.

Unit 10: Late Embryonic Development
Types of Placenta and their function; Placenta formation in Human.

Unit 11: Control of Development
Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, cell movements and cell death.

Suggested Readings:

1. Carlson, Bruce M (1996). Patten's Foundations of Embryology, McGraw Hill, Inc.
2. Gilbert, S. F. (2006). Developmental Biology, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
3. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons.
4. Jordon & Verma . Chordate Emcryp;gy. S. Chand Pub. New Delhi.
5. Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
6. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies.
7. Saxena, R.A. & Saxena, S. Coperative Anatomy of Vertebrates. Viva Publication.Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House.

3.4 Core P2 - Comparative anatomy and Developmental Biology of Vertebrate

Comparative anatomy and Developmental Biology of Vertebrate Lab **2 Credits**

Practicals

1. Osteology:

Identification of

a) limb bones and girdles of *Columba* and *Cavia*

b) Carapace and plastron of turtle (model/photograph)

c) Mammalian skulls: Guinea pig and Dog.

2. Identification of whole mounts of developmental stages of chick through permanent slides: 24 and 48 hours of incubation.

3. Identification of different sections of placenta (epitheliochorial, endotheliochorial and hemochorial) (photomicrograph/ slides).

5. Submission of laboratory note book

Distribution of marks	**Full Marks: 15**
1. Spot identification (any four from item 1)	(4x2) = 8
2. Spot identification (any two; one from item 2 & 3)	(2x2½)) = 05
3. Submission of laboratory note book	= 2

Note: Q1. ½ mark for identification and 1 ½ mark for reasons.

Q2. 1 mark for identification and 1 ½ mark for reasons.

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology

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

3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

3.5 Core T3 – Physiology and Biochemistry

Physiology and Biochemistry **4 Credits**

Theory

Unit 1: Digestion
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit 2: Respiration
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 3: Cardiovascular system
Structure of Heart, Cardiac cycle, Composition of blood, Blood Coagulation

Unit 4: Excretion
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Nerve and muscle
Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structureof skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 6: Reproduction and Endocrine Glands
Physiology of female reproduction: hormonal control of menstrual cycle Pituitary, thyroid, pancreas and adrenal: Structure and function.

Unit 7: Carbohydrate Metabolism
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, electron transport chain

Unit 8: Lipid Metabolism
β oxidation of palmitic acid

Unit 9: Protein metabolism
Transamination, Deamination and Urea Cycle

Unit 10: Enzymes
Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation

SUGGESTED READINGS

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edn. W.H Freeman & Co.
2. Chatterjea, MN and Shinde, R (2012) . A Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N.Delhi
3. Das, D. (200). Biochemistry. Central Book Agency, Kolkata
4. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
5. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper'sIllustrated Biochemistry. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.
6. Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). Principles of Biochemistry. IV Edition. W.H. Freeman and Co.
7. Sathyanarayana U. and Chakrapani, (2002). Biochemistry –Books & Allied (P) Ltd, Kolkata
8. Sembulingam and Sembulingam (2012) Essentials of Medical Physiology. 6th Edn. Jaypee Pub, New Delhi
9. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
10. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.

3.6 Core P3 – Physiology and Biochemistry

Physiology and Biochemistry Lab **2 Credits**

List of Practical

1. Preparation of haemin crystals
2. Identification of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Identification of permanent slides / photomicrograph of spinal cord, liver, lung, kidney, Cartilage, Bone
4. Qualitative tests for Glucose (Benedict's test) and Sucrose (Iodine test)
5. Estimation of total protein (Lowry's method.)
6. Study of activity of amylase (Effect of Temperature)
7. Submission of Laboratory Note Book

Distribution of marks	**Full Marks: 15**
1. One question on Qualitative test (Item No. 4)	03
2. One question on quantitative test (From Item 5)	04
3. One Experiment (From Item no. 1 or .6)	03
4. Identification of histological section [(From Item No. 2 and 3) any two]	(2×1 ½) = 03
5. Laboratory Note Book	02

Note:

Q1. Principle 1 marks and result 2 marks

Q2. Principle 1 marks and result 3 marks

Q3. Principle 1 marks and result 2 marks

Q4. ½ marks for identification and 1 mark for reasons each

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

3.7 Core T4 - Genetics and Evolutionary Biology

Genetics and Evolutionary Biology Theory 4 Credits

Theory

Unit 1: Introduction to Genetics
Principles of Inheritance, Mendel's work on transmission of traits.

Unit 2: Extension of Mendelian Genetics
Chromosome theory of inheritance, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, Extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence.

Unit 4: Mutations
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations; Induced versus Spontaneous mutations;

Unit 5: Sex Determination
Chromosomal mechanisms; dosage compensation in *Drosophila*.

Unit 6: History of Life
Origin of Life, Geological time scale

Unit 7: Introduction to Evolutionary Theories
Lamarckism, Darwinism, Neo-Darwinism, Modern Synthetic Theory

Unit 8: Direct Evidences of Evolution
Types of fossils, fossilization, Dating of fossils, Evolution of man.

Unit 9: Processes of Evolutionary Change
Speciation; Isolating Mechanisms; Modes of speciation (Allopatric, Sympatric) Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive),

Unit 10: Species Concept
Biological, Typological and Evolutionary species concept (Advantages and Limitations)

Unit 11: Macro-evolution
Macro-evolutionary Principles (example: Darwin's Finches); Basic understanding of Micro-evolution.

Unit 12: Extinction
Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution, Anthropogenic extinction.

SUGGESTED READINGS

1. Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). Evolution. Cold Spring, Harbour Laboratory Press.
2. Brooker, R.J. (2012). GeneticsL Analysis and Principles. 4th Edn. McGraw Hill.
3. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
4. Futuyma, D. J. (1997). Evolutionary Biology. Sinauer Associates.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Ed. Wiley India.
6. Griffiths ,A.J.F.,Wessler,S.R.,Lewontin,R.C.andCarroll,S.B. (2010). Introduction to Genetic Analysis WH Freeman.
7. Hall, B. K. and Hallgrimsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
8. Hyde, D. (2009). Introduction to Genetic Principle. McGraw Hill.

9. Kardong, K. (2004). An Introduction to Biological Evolution. McGraw Hill.
10. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
11. Pierce, B.A. (2013). Genetics Essebtials: Concepts abd Connections. 2 nd Edn. Freeman W.H.
12. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
13. Russel, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
14. Snustad, D.P., Simmons,M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

3.8 Core P 4 - Genetics and Evolutionary Biology

Genetics and Evolutionary Biology Lab **2 Credits**

Practicals

1. Identification of major group of fossils from models/ pictures (Petrified fossil, molds, casts, carbon film, trace fossil)
2. Identification of Human Karyotypes (Normal karyotype, Down, Klinefelter's, Turner, Cri-du-Chat syndrome) from photograph
3. Identification of homology and analogy from suitable specimens / pictures,
4. Linkage maps based on Drosophila crosses
5. Identification of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test
6. Submission of Laboratory Note Book

Distribution of marks **Full Marks: 15**

1. Identification with reasons (any four from item 1, 2 and 3) [at least one from each group] = 08 (4×2)
2. One question (From Item 4 or 5) = 05
3. Laboratory Note Book = 02

Note

Q 1. ½ mark for identification and 1½ mark for reasons

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

4.1 DSE T1 - Applied Zoology

Applied Zoology 4 Credits

Theory

Unit 1: Introduction to Host-parasite Relationship
Host, Definitive host, Intermediate host, Parasitism, Mutualism, Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases
Transmission, Prevention and control of diseases: Tuberculosis, typhoid

Unit 3: Rickettsiae and Spirochaetes
Brief account of *Rickettsia prowazekii, Borrelia recurrentis* and *Treponema pallidum*

Unit 4: Parasitic Protozoa
Life history and pathogenicity of *Entamoeba histolytica, Plasmodium vivax* and *Trypanosoma gambiense*

Unit 5: Parasitic Helminthes
Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*

Unit 6: Insects of Economic Importance
Biology, Control and damage caused by *Helicoverpa armigera*, *Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae*

Unit 7: Insects of Medical Importance
Medical importance and control of *Pediculus*, *Anopheles, Culex, Aedes,*

Unit 8: Animal Husbandry
Types of Cattle breed, Artificial insemination in cattle

Unit 9: Poultry Farming
Principles of poultry breeding, Management of breeding stock and broilers, Deep litter system

Unit 10: Fish Farming
Pond management, Composite fish culture, Induced breeding and transportation of fish seed

SUGGESTED READINGS

1. Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
2. Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
3. Banerjee, G.C. (2018). Animal husbandry. Oxford and IBH
4. Chatterjee, K. D. (2009).Parasitology: Protozoology and Helminthology. XIII Edition, CBS Publishers & Distributors(P) Ltd
5. Dennis, H. (2009). *Agricultural Entomology*. Timber Press (OR).
6. Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approache*s. CABI publications, U.K.
7. Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
8. Kumar and Corton. *Pathological Basis of Diseases*.
9. Paniker, C.K.J., Ghosh, S. [Ed} (2013). Paniker's Text Book of Medical Parasitology. Jaypee, New Delhi.
10. Parija, S.C. Text book of medical parasitology, protozoology & helminthology (Text and colour Atlas), II Edition, All India Publishers & Distributers, Medical Books Publishers, Chennai, Delhi
11. Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
12. Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

4.2 DSE P1 - Applied Zoology

Applied Zoology Lab **2 Credits**

Practicals

1. Identification of *Plasmodium vivax*, *Entamoeba histolytica, Trypanosoma gambiense, Ancylostoma duodenale* and *Wuchereria bancrofti* and their life stages through permanent slides/photomicrographs or specimens.
2. Identification of arthropod vectors associated with human diseases: *Pediculus, Culex, Anopheles, Aedes*
3. Identification of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of *Nilaparvata lugens, Apion corchori, Scirpophaga incertulus, Sitophilus oryzae*
5. Visit to fish farm, poultry farm or animal breeding centre. Submission of visit report
6. Submission of laboratory note book

Distribution of marks **Full Marks: 15**

1. Identification with reasons (any 4 from Item No. 1,2 and 3; at least one from each group)	(4 × 2) =08
2. Identification and economic importance (any two) from Item No. 4	(1 ½ × 2) = 03
3. Field Report (Item 5)	= 2
4.Laboratory Note Book	= 2

Note

Q 1. ½ mark for identification and 1½ mark for reasons.

. Q2 ½ mark for identification and 1 mark for economic importance

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

4.3 DSE T2a - Insect Vectors and Diseases

Insect Vectors and Diseases **4 Credits**

Theory

Unit I: Introduction to Insects
General Features of Insects, Morphological features, Compound Eye, Types of antennae, Mouth parts with reference to feeding habits

Unit II: Concept of Vectors
Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Adaptations as vectors, Host Specificity

Unit III: Insects as Vectors
Outline Classification of Insecta upto Order, Characteristic features of Order Diptera, Siphonoptera, Sipunculata, Hemiptera

Unit IV: Dipteran as Disease Vectors
Dipterans as vectors – Mosquitoes, Sand fly, Houseflies; Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya,Filariasis; Control of mosquitoes

Unit V: Siphonaptera as Disease Vectors
Fleas as vectors; Host-specificity, Study of Flea-borne diseases –Plague, Typhus fever; Control of fleas

Unit VI: Sipunculata as Disease Vectors
Human louse (Head, Body and Pubic louse) as vectors; –Typhus fever, Control of human louse

Unit VII: Hempitera as Disease Vectors
Bugs as; Blood-sucking; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

Suggested Readings:

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

4.4 DSE P2a - Insect Vectors and Diseases

Insect Vectors and Diseases Lab **2 Credits**

Practical

1. Mounting of mouthparts of Mosquito and Cockroach
2. Identification of following insect vectors through permanent slides/ photographs:, *Xenopsylla, Cimex, Phlebotomus, Musca*
3. Submission of a project report on any one of the insect vectors and disease transmitted
5. Submission of laboratory note book

Distribution of marks **Full Marks: 15**

1. Mounting (any one from Item no. 1)	= 04
2. Identification of vector and disease transmission (any 3 from Item No. 2)	(3× 2) = 06
4. Submission of Project Report	= 3
5. Submission of Laboratory Note Book	= 2

Note

Q 1. 2mark for mounting and 2 mark for drawing and labelling
Q 2. ½ mark for identification and 1½ mark about disease transmitted

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

4.5 DSE T2b - Aquatic Biology

Aquatic Biology **4 Credits**

Theory

UNIT 1: Aquatic Biomes
Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), marine ecosystem; estuaries; intertidal zones, oceanic pelagic zone, marine benthic zone

UNIT 2: Freshwater Biology
Lakes: Origin and classification, 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

SUGGESTED READINGS

1. Anathakrishnan : Bio resources Ecology 3rdEdition
2. Goldman : Limnology, 2ndEdition
3. Odum and Barrett : Fundamentals of Ecology, 5thEdition
4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1stEdition
5. Trivedi and Goyal : Chemical and biological methods for water pollution studies
6. Welch : Limnology Vols. I-II
7. Wetzel : Limnology, 3rdedition

4.6 DSE P2b - Aquatic Biology

Aquatic Biology Lab **2 Credits**

Practicals

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

Distribution of marks **Full marks: 15**

1. Identification with reasons (any three) [From Item 1 and 3]	[2×3] = 6
2. One experiment (pH/ free CO_2) (Item 2)	[2+3] = 5
3. Field visit Report (From Item 4):	2
4. Submission of laboratory note book:	2

Note

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

Q 2. For Principle 2 marks and for result 3 marks

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

DSE 4.7 Immunology

Immunology **4 Credits**

Unit 1: **Overview of the Immune System**
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system

Unit 2: **Cells and Organs of the Immune System**
Haematopoeisis, Cells and organs of immune system (primary and secondary lymphoid organs) of the immune system

Unit 3: Antigens
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants

Unit 4: **Antibodies**
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis

Unit 5: **Working of the immune system**
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.

Unit 6: **Immune system in health and disease**
Brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency

Unit 7: Vaccines
General introduction to vaccines, Various types of vaccines, Principle of action of Covaxin against Corona Virus

Suggested Reading

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 9. Virella, G (2007). Medical Immunology 6th Edn. Informa Healthcare

DSE 4.8 Immunology Lab

Immunology Lab **2 Credits**

PRACTICAL

1. Identification of lymphoid organs of human (Model/Photograph).
2. Identification of histological section of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
4. ABO blood group determination.
5. Demonstration of

a) ELISA

b) Immuno-electrophoresis

6. Submission of Laboratory Note Book

Distribution of Marks

	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. Blood group determination (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

Suggested Readings:

1. Chatterjee and Chatterjee: Practical Zoology
2. Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
3. Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay Advanced Practical Zoology

5. Skill Enhancement Course

5.1 SEC T1 – Apiculture (Economic Zoology)

Apiculture (Economic Zoology) 2 Credits

Unit 1: Biology of Bees
1. Classification and Biology of Honey Bees
2. Social Organization of Bee Colony

Unit 2: Rearing of Bees
1. Artificial Bee rearing (Apiary), Beehives - Newton and Langstroth
2. Bee Pasturage
3. Selection of Bee Species for Apiculture
4. Bee Keeping Equipment
5. Methods of Extraction of Honey (Indigenous and Modern)

Unit 3 Diseases and Enemies
1. Bee Diseases and Enemies
2. Control and Preventive measures

Unit 4: Bee Economy
Products of Apiculture Industry and its uses (Honey, Bees Wax, Propolis)

Unit 5: Entrepreneurship in Apiculture
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Bee hives for cross pollination in horticultural gardens

5.2 SEC T2 Aquarium Fish Keeping (Economic Zoology)

Aquarium Fish Keeping 2 credits

Unit 1: Introduction to Aquarium Fish Keeping
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, Angel fish, 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

5.3 SEC T3 Sericulture (Economic Zoology)

Sericulture (Economic Zoology) **2 Credits**

Unit 1: Introduction
1. Types of silkworms, Distribution and Races
2. Exotic and indigenous races
3. Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm
1. Life cycle of *Bombyx mori*
2. Structure of silk gland and secretion of silk

Unit 3: Rearing of Silkworms
1. Selection of mulberry variety and establishment of mulberry garden
2. Rearing house and rearing appliances..
3. Disinfectants: Formalin, bleaching powder, RKO
4. Silkworm rearing technology: Early age and Late age rearing
5. Types of mountages
6. Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases
1. Pests of silkworm
2. Diseases: Protozoan, viral, fungal and bacterial
3. Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture
Prospects of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture; Visit to sericulture centers.

5.4 SEC T4 Medical Techniques

Medical Techniques **2 Credits**

Unit 1:
Introduction to Medical Diagnostics and its Importance

Unit 2:
Diagnostics Methods Used for Analysis of Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

Unit 3:
Diagnostic Methods used for Urine Analysis: Physical characteristics: Abnormal constituents

Unit 4:
Non-infectious Diseases, Diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer / Kit

Unit 5:
Infectious Diseases Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis, Malarial parasite (Microscope based and ELISA based)

Unit 6:
, Clinical Biochemistry LFT, Lipid profiling

Unit 7: Tumours Types (Benign/Malignant), Detection and metastasis: Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).