Syllabus for
Four Years Undergraduate Courses
in
Zoology

[New Curriculum and Credit Framework for undergraduate Programme]

Following NEP 2020

With effect from the Academic Session 2023-24

BANKURA UNIVERSITY

BANKURA

WEST BENGAL

PIN 722155

Medium of study and question paper is English in Major and SEC papers for NEP curriculum

CONTENTS

Introduction:

The syllabus for Zoology at undergraduate level using the NEP-2020 and formulation of a new student-centric **"Curriculum and Credit Frame work for Undergraduate Programmes (CCFUD)",** the syllabus for Zoology has been framed following the UGC guidelines facilitating students to pursue their career path by choosing the subject. 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. The incorporation of a flexible choice-based credit system, a multidisciplinary approach, and many entry and exit alternatives with a focus on the students' chosen majors and minors has been done correctly in accordance with our own infrastructure, competence, and strength.

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. In addition scope of research and summer internship has been introduced in the new syllabus.

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Programme and Course Structure with Credit Distribution: UG Degree Programmes with Single Major (Zoology)

Category ofCourse (credit) SEM	Major (04)		Minor Stream (4)	Multidisciplinary (3)	Skill Enhancement Courses (SEC) (3)	Ability Enhancement Courses (AEC) (2)	Value Added Courses (common for all) (4)	Internship (2)	Research Project / Dissertation* (12)	TOTAL CREDIT / NUMBEROF COURSES
	DSC	DSE								
I	1x4=4 X/Y/101/MJC-1		1x4 = 4 X/Y/102/MN-1	1x3 = 3 X/Y/103/MD-1	1x3 = 3 X/Y/104/SEC-1	1x2=2 ACS/105/AEC-1	1x4 = 4 ACS/106/VAC-1			20 / 6
II	1x4=4 X/Y/201/MJC-2		1x4 = 4 X/Y/202/MN-2	1x3 = 3 X/Y/203/MD-2	1x3 = 3 X/Y/204/SEC-2	1x2=2 ACS/205/AEC-2	1x4 = 4 ACS/206/VAC-2			20 / 6
CERTIFICATE (Total credit)	8		8	6	4		6	4*(ADDITIONAL) ACS/207/INT-1		40
III	2X4=8 X/Y/301/MJC-3 X/Y/301/MJC-4		1X4=4 X/Y/303/MN-3	1X3=3 X/Y/304/MD-3	1x3 = 3 X/Y/305/SEC-3	1x2=2 ACS/306/AEC-3				20 / 6
IV	4X4=16 X/Y/401/MJC-5 X/Y/402/MJC-6 X/Y/401/MJC-7 X/Y/402/MJC-8		1X4=4 X/Y/405/MN-4			1x2=2 ACS/406/AEC-4				22 / 6
DIPLOMA (Total credit)	32		16	9	9	8	8	4*(ADDITIONAL) ACS/407/INT-2		82
V	4X4=16 X/Y/501/ MJC-9 X/Y/502/ MJC-10 X/Y/501/ MJC-11 X/Y/502/ MJC-12		1X4=4 X/Y/505/MN-5					1X2=2 ACS/506/INT-3		22 / 6
VI	3X4=12 X/Y/602/ MJC-13 X/Y/601/ MJC-14 X/Y/603/ MJC-15 X/Y/602/ MJC-16		1X4=4 X/Y/605/MN-6							20 / 6
UG DEGREE (Total credit)	16X4=64 64		24	9	9	8	8	2		124
VII	4X4=16 X/Y/701/ MJC-17 X/Y/702/ MJC-18 X/Y/703/ MJC-19 X/Y/704/ MJC-20		1X4=4 X/Y/705/MN-7							20 / 5
VIII	4X4=16** X/Y/801/ MJC-21 X/Y/801/ MJC-22 X/Y/801/ MJC-23 X/Y/801/ MJC-24		1X4=4 X/Y/805/MN-8							20 / 5
UG HONS. (Total credit)	24X4=96 96		32	9	9	8	8	2		164
UG HONS. WITH RESEARCH (Total credit)	21X4=84		32	9	9	8	8	2	12** X/Y/806/RPD-1	

** Honours students not undertaking research will do 3 courses for 12 credits for Major in lieu of a research project / Dissertation and total fourcourses in Major in VIII semester
Honours with Research students will opt any one core course from available four courses in Major in VIII semester

BANKURA UNIVERSITY

Curriculum Framework for UG Degree Programmes with Single Major (Zoology)

Semester	Major Paper (MJC)	Skill enhancement Course Paper (SEC)	Minor Paper (MN)	Multidisciplinary Paper (MD)
I	Non Chordate Diversity	Sericulture	Non Chordate	Sericulture and Silk production Technology
II	Chordate diversity and Comparative anatomy of Vertebrate	Aquarium fish Management	Chordate and Comparative Anatomy	Environment and Public Health Management
III	Ecology Fundamentals of Biochemistry	Economic Zoology	Physiology and Biochemistry	Apiculture
IV	Cell Biology Animal Physiology Life sustaining System Developmental Biology Evolutionary Biology		Genetics and Evolution	
V	Molecular Biology Genetics Animal Behaviour and Chronobiology Endocrinology		Cell and Molecular Biology	
VI	Immunology Biology of Insecta Parasitology Microbiology		Parasitology and Vector Biology	
VII	Biotechnology and Bioinformatics Biostatistics and Biophysics Histology and Histochemistry Fish and Fisheries		Developmental Biology	
VIII (With Research)	Bioinstrumentation and Research Methodology Research Project (12 Credit)		Ecology and conservation Biology	
VIII (Without Research)	Bioinstrumentation and Research Methodology Environmental Chemistry and Toxicology Biodiversity and Conservation Biology Medical techniques			

Curriculum and Credit Framework for ZOOLOGY

(Basic, Honours and Honours with Research)

With effect from the Academic Year 2023-24

SEMESTER–I

Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/101/MJC-1	Nonchordate Diversity (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	0	2
2	S/ZOO/102/MN-1	Nonchordate (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	0	2
3	S/ZOO/103/MD-1	Sericulture and Silk Production Technology (For students of other discipline)	3(T)	10	40	50	3	NA	NA
4	S/ZOO/104/SEC-1	Sericulture	3(T)	10	40	50	3	NA	NA
5	ACS/105/AEC-1	Communicative English	2	10	40	50	2	NA	NA
6	ACS/106/VAC-1	Environmental Studies	4	10	40	50	4	NA	NA
Total in Semester-I			**20**	**60**	**240**	**300**			

SEMESTER–II

Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/201/MJC-2	Chordate Diversity and Comparative Anatomy of Vertebrates (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
2	S/ZOO/202/MN-2	Chordate and Comparative Anatomy (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
3	S/ZOO/203/MD-2	Environment and Public Health Management	3(T)	10	40	50	3	NA	NA
4	S/ZOO/204/SEC-2	Aquarium Fish Management	3(T)	10	40	50	3	NA	NA
4	**ACS/205/AEC-2**	MIL (Santali/Bengali/Sanskrit)	2	10	40	50	2	NA	NA
6	**ACS/206/VAC-2**	Understanding India/Health and wellness	4	10	40	50	4	NA	NA
Total in Semester-II			**20**	**60**	**240**	**300**			

SEMESTER–III									
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/301/MJC-3	Ecology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
2	S/ZOO/302/MJC-4	Fundamentals of Biochemistry (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
3	S/ZOO/303/MN-3	Physiology and Biochemistry (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
4	S/ZOO/304/MD-3	Apiculture	3(T)	10	40	50	3	NA	NA
5	S/ZOO/305/SEC-3	Economic Zoology	3(T)	10	40	50	3	NA	NA
6	ACS/306/AEC-3	MIL-II (Santali/Bengali/Sanskrit)	2	10	40	50	2	NA	NA
Total in Semester-III			**20**	**60**	**240**	**300**			

SEMESTER–IV									
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/401/MJC-5	Cell Biology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
2	S/ZOO/402/MJC-6	Animal Physiology: Life sustaining System (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
3	S/ZOO/403/MJC-7	Developmental Biology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
4	S/ZOO/404/MJC-8	Evolutionary Biology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
5	S/ZOO/405/MN-4	Genetics and Evolution (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
6	ACS/406/AEC-4	Compulsory English: Literature, Language and Communication	2	10	40	50	2	NA	NA
Total in Semester-IV			**22**	**60**	**240**	**300**			

SEMESTER– V									
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/501/MJC-9	Molecular Biology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
2	S/ZOO/502/MJC-10	Genetics (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
3	S/ZOO/503/MJC-11	Animal Behaviour & Chronobiology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
4	S/ZOO/504/MJC-12	Endocrinology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
5	S/ZOO/505/MN-5	Cell and Molecular Biology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
Total in Semester-V			**20**	**50**	**200**	**250**			

SEMESTER– VI									
Sl. No.	Course Code	Course Title	Credit	Marks			No. of Hours		
				IA	ESE	Total	L	T	P
1	S/ZOO/601/MJC-13	Immunology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
2	S/ZOO/602/MJC-14	Biology of Insecta (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
3	S/ZOO/603/MJC-15	Parasitology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
4	S/ZOO/604/MJC-16	Microbiology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
5	S/ZOO/605/MN-6	Parasitology and Vector Biology (Theory & Practical)	4 (T+P)	10	40 (T:25 P:15)	50	3	NA	2
Total in Semester-VI			**20**	**50**	**200**	**250**			

- Major Courses in Zoology are for the students who opted for Certificate/Diploma/Degree in Zoology
- Minor Courses in Zoology for the students opted whose major courses other than Zoology.
- Multidisciplinary subject (for the students who donot studied the subject in H.S. level).
- Skill Enhancement Course (SEC)for the students of Zoology Major.
- Internship of 4 credits is compulsory within1st year for Certificate, within 2nd year for Diploma.
- **Internship of 2 credits is compulsory for all students of Sem V.**

Question pattern for Zoology

For 25 Marks paper

Sl No.	Questions to be answered	Out of	Marks of each questions	Total Marks
1	5	8	1	5X1=05
2	2	4	5	2X5= 10
3	1	2	10	1X10=10

For 40 Marks paper

Sl No.	Questions to be answered	Out of	Marks of each questions	Total Marks
1	5	8	2	5X2= 10
2	4	6	5	4X5=20
3	1	2	10	1X10=10

Programme Outcome of Zoology (PO)

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

Programme Specific Outcomes of Zoology (PSO)

PSO	Description
PSO.1	**The core courses include diversified fields of life sciences viz:** a) Overall concept of living organisms with special reference to animal kingdom; wherein it would be possible for the learners to have an idea of diverse group of animals, their structural aspects with functional anatomy . b) Concept of classifying these diversified groups of animals using taxonomical approaches. Evolutions of animals are studied by following evolutionary principles. c) Idea of developing ecological concepts in relation to individual, population and community along with the roles in organizing ecosystems and other structural and functional components. d) Similarities in Biochemistry, physiology and molecular aspects of all living organisms are taught in the light of modern approaches to develop the concept and generate interest. e) Molecular biological parameters in the form of DNA, RNA and proteins and their similarities and uniqueness in all living organisms. f) Protective approaches of animals against infectious diseases termed as immunity are studied to develop global concept of immunity following immunological principles. g) Development of animals from fertilized embryo is studied in relation to amphibian and avian embryonic development to have an overall concept of developmental pattern in animals. h) Endocrine regulation and coordination of different physiological system are studied in an independent course in the form of endocrinology. i) Heredity and variation of animals are studied following the general principles of genetics. Therefore using these study materials it becomes possible for the learners to develop Improved knowledge on the field.
PSO.2	Applied zoology in the form of fish farming, poultry etc. Are studied in dependently by including separate programme called department specific elective in broader perspective so that the learners become seriously devoted to the subject.
PSO.3	Skill enhancement courses are introduced such as medical technology……..etc. to develop Specific skill in the area of self development to start the learners own laboratories.
PSO.4	Generic Elective courses have been incorporated as interdisciplinary to teach overall concept of the subject so that student from other discipline may choose the courses according to their interest.
PSO.5	Students ripen their investigative proficiency so that they can open up the entrances of the future knowledge world.
PSO.6	To help the students for development of essential academic skills like critical thinking, analytical reasoning, research skills to identifying various Invertebrate and Vertebrate fauna and their classification as well as to understand the relations among these organisms with an evolutionary perspective.
PSO.7	Students will be able to analyze and solve the problems related to animal sciences without relying on assumptions and guesses.
PSO.8	Students will be able to make solutions of biological problems by experimentation and Subsequent data processing by modern technologies and computer applications.

PSO.9	The programme will fortify the students to develop fundamental knowledge in biodiversity and their conservation, pollution of environment and their control measures.
PSO.10	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.
PSO.11	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.
PSO.12	The programme will strengthen the students for developing laboratory skills for Genetics and Molecular Biology. The laboratory programme will enable them to learn the techniques for the qualitative as well as quantitative assays of bio molecules.
PSO.13	They will understand the importance and role biodiversity and can recognize the Economically important animals around us.
PSO.14	Students will be able to learn about different diseases, causative organisms, parasites, hosts, vectors aswellas the basic principles of immunology including vaccinations and genetic basis several diseases like cancer.
PSO.15	The programme will strengthen the students to understand the structure and function of the gene, chromosomes, genome, cell, tissue, organ and organ-system.
PSO.16	They will understand the importance of the physiological adaptations, development pathways, hormonal regulation of reproduction and other physiologica lmechanisms.
PSO.17	Another important programme outcome will be the ability of students to estimate various important environmental parameters like O_2, CO_2 content, Ph, water turbulence, temperature, salinity, nutrient content.
PSO.18	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.
PSO.19	Project work and field study provide them with an encouragement for self-learning.
PSO.20	Research Motivation is also another significant outcome that the students are endowed with on the completion of the programme.

Zoology Major-1

Semester-I

MJC-1: Non-Chordate Diversity (Theory) 3Credits

Course Outcomes:

1. This course includes the concept of living organisms which are grouped into six kingdoms and the idea behind such grouping. Knowing the differences among other five non-animal to that of animal kingdom enables to have a clear idea of animal characteristics.
2. To study animals in systematic pattern it needs to classify animal groups using taxonomical principles. Therefore Taxonomy is incorporated in the course.
3. The common structural pattern of all animals is considered in the form of symmetry.
4. The protozoans are animal protists therefore these find inclusion in studying zoology and this course includes Protozoans to Pseudocoelamates. Pseudocoelmates are triploblastic animals without true coelom and therefore the topic of development of coelome is also included. Thus non-chordate I contents teaches on the basics of animal characters and their organized study methods.
5. Non-chordates includes topics of metamerism in animals with special reference to annelids to know the metamerism in all higher groups which is not present in earlier groups already studied in non-chordate-I.
6. The coursealsoincludesclassificatoryschemes,structuralandfunctionalaspectsofthenon-chordategroupsfromannelidsto echinoderms.

Unit1: Introduction

Coelom: Types, Evolution and significance

Unit2: 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 (CarlWoese)

Unit3: Protista

Protozoa:

General characteristics and classification up to phylum (Levineet.al.,1981)

Locomotion in Protozoa with special reference to *Euglena, Paramoecium* and *Amoeba*; Conjugation in *Paramoecium.*

Unit4: Porifera

1. General characteristics and classification up to Classes (Hyman1940)
2. .Canal system and spicules in sponges

Unit5: Cnidaria

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

Unit6: Platyhelminthes

General characteristics and classification up to classes

Unit7: Nematoda

1. General characteristics and classification up to classes
2. Parasitic adaptations in helminthes

Unit8: Annelida

1. General characteristics and classification up to classes
2. Reproduction in earthworm.

Unit9: Arthropoda

1. General characteristics and classification up to classes
2. Social life in termite
3. Insect Metamorphosis

Unit10: Onychophora

General characteristics and Evolutionary significance of *Peripatus*

Unit11: Mollusca

1. General characteristics and Classification up to classes
2. Nervous system and torsion in Gastropoda

Unit12: Echinodermata

1. General characteristics and Classification up to classes
2. Water-vascular system in *Asterias*

Unit13: Hemichordata

1. General characteristics of phylum Hemichordata.
2. Evolutionary significance of Hemichordates

Note: Classification to be followed from Barnes and Ruppert 1994, 6th Edition

Reference Books

Barnes, R. D. & Ruppert, E. E., (1994). Invertebrate Zoology. 6th Ed. Brooks
ColeBrusca,R.C.&Brusca,G.J.(2002).Invertebrates.4thEd.SinauerAssociatesManda
lFB(2015), HumanParasitology2ndEdition,PHILearning
Kapoor,V.C.(2008).Theoryandpracticeofanimaltaxonomy.6thEd.Oxford&IBHPubMayr,E.
(1969).Principles of Systematic Zoology. TataMcGraw-Hill.
Mayr,E.&Ashlock,P.D.(1991).PrinciplesofSystematicZoology.2ndEd.,McGraw-
Hill.Meglitsch,P.A.&Schram,F.R.(1991).InvertebrateZoology. Oxford University
PressPechenik,J.A.(1998).Biologyofthe Invertebrates,4thEd.McGrawHill
RuppertandBarnes,R.D.(2006).InvertebrateZoology,VIIIEdition.HoltSaundersInternationalEdition.Sinha,K.S.,Adhikari
,S.,&Ganguly,B.B.BiologyofAnimals.Vol.I.NewCentralBookAgency.Kolkata

MJC-1: Non-ChordateDiversity (Practical) 1Credit

Course Outcomes:
The Laboratory on the course approaches to teach the diverse kinds of animals from Protozoan to Hemichordata by observing the real animal groups and their identifying characters.

Practicals

1. Identification of following specimen
   Amoeba,Euglena,Paramecium,Sycon,Fasciola,AscarisPhysalia,Aurelia,Gorgonia,Metridium,Pennatula,Fungia,Aphrodite,Pheretima,Hirudinaria,B alanus,Eupagurus,Scolopendra,Peripatus,Chiton,Pinctada,Octopus,Nautilus,Asterias,Balanoglossus
2. Identification of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm
3. Dissection of digestive system and nervous system of earthworm
4. Dissection of reproductive system of earthworm
5. Dissection: digestive system and nervous system of Cockroach
6. a. Mounting of mouth parts of Cockroach
   b. Staining and mounting of any protozoa/helminthes from gut of cockroach.
7. Submission of Laboratory Note Book

Distribution of Marks

Examination Pattern:	**Fullmarks:15**
1. Identification with reasons (any three):	3x2=6
2. Dissection (any one) (From Item no.3,4and5)	4[2+1=1]
3. Staining/Mounting (anyone) (FromItemno.6):	3[1+1+1]
4. Laboratory Notebook	2

***Note:**

Q1.For Item (1), Sc.name: 0.5 mark, Systematic Position 0.5 and Reasons:1mark
For Item (2) 1mark is allotted for both identification and characters.

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

Zoology Major-2

Semester-II

MJC-2: Chordate Diversity and Comparative Anatomy of Vertebrate (Theory) 3 Credits

Course Outcomes:

This course is intended to provide students with a fundamental grasp of the diversity of the Phylum Chordata, with a focus on their origin, major traits, classification, distribution, and functioning. This course will enlighten students on the concept of Chordate diversity, organization, adaptation, and taxonomic position. The course will teach students about chordate systemic physiology and comparative anatomy of chordates. There will be a discussion regarding the chordate's affinities to various groups. Students learn about venom's composition and significance. Learn about the structural characteristics of birds that will aid them in Poultry (commercial application). Mammal adaptive radiation will shed light on the diversity and distribution of mammals.

Group-A

Unit1: Introduction to Chordates

Origin of Chordate (Dipleurula concept and the Echinoderm theory)

Unit2: Urochordata and Cephalochordata

1. General characteristics and classification of Urochordata and Cephalochordata up to Classes.
2. Retrogressive metamorphosis in *Ascidia*.

Unit3: Agnatha

General characteristics and classification of cyclostomes up to order

Unit4: Pisces

1. General characteristics and classification of Chondrichthyes and Osteichthyes up to Subclasses
2. Migration in fishes
3. Structure and function of Swim bladder

Unit5: Amphibia

1. General characteristics and classification up to living Orders.
2. Parental care in Amphibia

Unit6: Reptilia

1. General characteristics and classification up to living Orders.
2. Poison apparatus and biting mechanism in snakes

Unit7: Aves

1. General characteristics and classification upto Sub-Classes
2. Migration in birds
3. Aerodynamics of flight

Unit 8: Mammals

1. General characters and classification up to living orders
2. Affinities and phylogeny of Monotremata
3. Echolocation in microchiropterans

GROUP-B

Unit 9: Integumentary System

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

Unit10: Skeletal System

General idea of Axial and appendicular Skeleton

Unit 11: Digestive System

Ruminating stomach; dentition in mammals

Unit 12: Respiratory System
Respiratory organs in fish, amphibian, and birds

Unit 13: Circulatory System
Comparative account of heart and aortic arches

Unit 14: Urinogenital System
Archinephros, Pronephros, Mesonephros and Metanephros
Evolution of urinogenital ducts,

Unit 15: Nervous System
Comparative account of brain, Cranial nerves in mammals

Unit 16: Sense Organs
Classification of receptors

Note: Classifications for Protochordata, Agnatha, Reptilia, Aves and Mammalian 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 PubCo.
Futuyama,D.(1997).Evolutionary Biology.3rdEd.SinauerAssociates,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 & CompanyLtd.NewDelhi.
Kardong,K.V.(2002).Vertebrates:Comparativeanatomy,functionevolution.TataMcGrawHill.
Kent, G.C .& Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. Mc Graw Hill.
MandalF B (2013)Vertebrate Zoology, Oxford and IBH Co Pvt Ltd, New Delhi
Nelson,J.S.,(2006):Fishes of theWorld, 4thEdn.,Wiley.
Parker,T.J.&Haswell,W.(1972).TextBookofZoology,VolumeII:MarshallandWiliam(Eds.)7thEd.MacmillanPress,London.
PoughH.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).BiologyofAnimals.Vol.II.NewCentralBookAgency(p)Ltd.
Young,J.Z. (2004).The Life of Vertebrates. Ill Edition. Oxford university press.
Kardong,K.V.(2005)Vertebrates'ComparativeAnatomy,FunctionandEvolution.IVEdition.McGraw-HillHigherEducation
Kent,G.C.andCarrR.K.(2000).ComparativeAnatomyoftheVertebrates.IXEdition.TheMcGraw-HillCompanies
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.

MJC-2: Chordate Diversity and Comparative Anatomy of Vertebrates (Practical) 1Credit

Course Out comes:
Students will learn how to explain the differences between Protochordates and Chordates.Students can able to recognise chordates' taxonomic place, diversity, and distribution. Learn about the economic value and significance of fishes. Identify and differentiate deadly and non-poisonous snakes by examining distinguishing characteristics.

Practicals

1. Identification of following specimen
   Branchiostoma,Petromyzon,Scoliodon,Torpedo,Heteropneustes,Exocoetus,Hippocampus,Necturus,Bufo,Tylototriton,Chelone,Chamaeleon,Draco,Vipera,Naja,Alcedo,Psittacula,Pteropus,Funambulus,
2. Identification of disarticulated skeleton of Pigeon and Guineapig [Skull,Vertebrae (Atlas,Axis), Pectoralgirdle,Pelvicgirdle],
3. Mounting of Pecten from Fowl head
4. Staining and mounting of Placoid, Cycloid and Ctenoid scales
5. Dissect out brain of carp
6. Dissection: Afferent branchial arterial system and IX & Xth Cranial nerves of carp
7. Submission of Laboratory Note Book

Distribution of Marks

Examination Pattern:	**Fullmarks:15**
1. Identification with reasons (any three;)	6(2+2+2)*
2. Mounting and staining	2
3. Dissection	5(3+1+1)*
4. Submission of laboratory note book:	2

Zoology Major-3

Semester–III

MJC-3: Ecology (Theory) 3Credits

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

Unit 1: Introduction to Ecology

1. History of ecology, autecology and synecology
2. Levels of organization
3. Study of Physical factors (Temperature and Light), Laws of limiting factors
4. Concept of Biosphere.

Unit 2: Ecosystem

1. Types of ecosystem w.r.t forest and marine ecosystem
2. Food chain: Detritus and grazing food chains, Food-web, Energy flow through the ecosystem with special emphasis on Linear and Y- shaped food chain
3. Ecological pyramids and ecological efficiencies

Unit 3: Community

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

Unit 4: Population

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

Unit 5: Applied Ecology

1. Concept of wild life
2. Biodiversity, Levels and Depletion of Biodiversity Wildlife Conservation (*in-situ* and *ex-situ* conservation),Wetland Conservation
3. Management strategies for tiger conservation; Wild life protection act (1972)

Reference Books:

Cain, Bowman & Hacker(2014)Ecology,3rdedition.Sinauerassociates
Chapman,R.L.andReiss,M.J.(2000).Ecology-Principles&Application.CambridgeUniversityPressDash,
M.C.,(2001).FundamentalofEcology.2ndEd.TataMcGraw-
HillCompanyKormondy,E.J.(2002).ConceptsofEcology.4thIndianReprint,PearsonEducation
Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
Odum,E.P.,(2008).FundamentalsofEcology.IndianEdition.Brooks/ColeRobertLeo
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.
VanDyke, F.(2008).Conservation Biology: Foundations, Concepts, Application.2nd Ed. Springer Science and Business Media.

MJC-3: Ecology (Practical) 1 Credit

Course out comes:

1. The laboratory aspect of the course is designed in such a way to develop idea on planktonic characters which are important constituents of aquatic food chain.
2. Beside there is the provision for study for community by enumeration of kinds and number of species present in a designated area.
3. Dissolved O_2 and CO_2content of water are also the topics to have the concept of polluted water.
4. Field visit to National Park/Biodiversity Park/Wild life sanctuary is included due to the fact that the students may be exposed to reality of the idea behind such measures and may also be competent enough to prepare report of their visit.

Practical

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. Field base experiment for data collection/Insect pit fall trapping/Light trapping/Quadrate sampling/Soil invertebrates sampling/ Bird feeder experiment (any two)
3. Study of an aquatic ecosystem: Zooplankton, Measurement of turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (modified Winkler's method), Chemical Oxygen Demand and free CO_2
4. Report on a visit to National Park/Zoological Park/Wildlife sanctuary/Marine biodiversity
5. Submission of Laboratory Note Book

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

1. Experiment (from Item no.1): 4
2. Experiment (from Item no.3; pH or free O_2 or free CO_2 estimation) 5 (2+3)*
3. Report on Excursion: 2
4. Submission of Laboratory note book: 2
5. Viva 2

Q2. Principle: 2 marks and result:3 marks

Suggested Reading

Desharnais Robert, Jeffrey Bell(2001)'Ecology Student Lab Manual, Biology Labs',
Benjamin Cummings DarrellSVodopich,(2009),'EcologyLabManual',McGraw-HillHigherEducation
Sinha,J.K.,Chatterjee,A.K.andP.Chattopadhyay(2015)AdvancedPracticalZoology,Books&Allied(P)Ltd

Zoology Major-4

Semester–III

MJC-4: Fundamentals of Biochemistry (Theory) 3 Credits

Course Out comes:

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

Unit 1: Carbohydrates

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

Unit 2: Lipids

1. Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri- acyl glycerols, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids and terpinoids.
2. Lipid metabolism: β-oxidation of fatty acids.

Unit 3: Proteins

1. Amino acids: Structure, Classification, General and Electrochemical properties of α-amino acids; Physiological importance of essential and non-essential amino acids.
2. Proteins: Bonds stabilizing protein structure; Levels of organization.
3. Protein metabolism: Transamination, Deamination, Urea cycle, Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

Unit 4: Nucleic Acids

1. Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids.
2. Types of DNA and RNA, Complementarily of DNA, Hypo-Hyper chromaticity of DNA.

Unit 5: Enzymes

1. Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes.
2. Mechanism of enzyme action: Enzyme kinetics; Derivation of Michaelis- Menten Equation, Lineweaver-Burk plot; Factors affecting rate of enzyme- catalyzed reactions.
3. Enzyme inhibition: Types and examples.
4. Strategy of enzyme action: Catalytic and Regulatory (Basic concept with one example each), Allosteric enzymes.

Reference Books:

Berg,J.M.,Tymoczko,J.L.andStryer,L.(2007).Biochemistry,VIEdition,W.H.FreemanandCo.,NewYork
Cox,M.MandNelson,D.L.(2008).Lehninger'sPrinciplesofBiochemistry,VEdition,W.H.FreemanandCo.,NewYork. Das, D.(2000).
Biochemistry. Central Book Agency, Kolkata
Hames,B.D.andHooper,N.M.(2000).InstantNotesinBiochemistry,IIEdition,BIOSScientificPublishersLtd.,U.K.
Murray,R.K.,Bender,D.A.,Botham,K.M.,Kennelly,P.J.,Rodwell,V.W.andWell,P.A.(2009).Harper'sIllustratedBiochemistry,XXVIIIEdition, International Edition,
The McGraw- Hill Companies Inc.
Rodwell(2018)HarpersIllustratedBiochemistry,31stEdn,McGrawHill
SathyanarayanaU.andChakrapani,(2002).Biochemistry–Books&Allied(P)Ltd,Kolkata
Voet.D&Voet.J.G,PrattCW(2012).PrinciplesofBiochemistry–4thedition,2004,JohnWiley&Sons,Inc.
Watson,J.D.,Baker,T.A.,Bell,S.P.,Gann,A.,Levine,M.andLosick,R.(2008).MolecularBiologyoftheGene,VIEdition,ColdSpringHarborLab. Press, Pearson Pub.
ZubayG.L,(1998).Biochemistry–4thedition,McGraw-Hill

MJC–4: Fundamentals of Biochemistry (Practical) 1 Credit

Course Outcomes:
This course will enable students to learn a number of experimental techniques like qualitative test of functional groups in biomolecules, quantitative estimation of protein, basic principles of paper chromatography and its use for mixture of amino acids separation as wellas 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 by salivary amylase/fungal diastase (Effect of temperature)
4. Paper chromatography of amino acid.
5. Submission of Laboratory Note Book

Distribution of Marks

Examination Pattern:	**Fullmarks:15**
1.Qualitative Test (anyone; From Item no.1):	3
2.Quantitative estimation of protein (Item no.2):	4
3.Experiment (From Item no.3 or 4)	4
4.Submission of laboratory note book	2
5. Viva	2

*Note:
Q1.Principle:1markand result 2 marks
Q2.Principle1marks and result 3marks
Q3. Principle 1 mark and result 3 marks

Suggested Reading:

Damodaran GK(2016). Practical Biochemistry,2nd edition Jaypee Brothers Medical Publishers;

Singh SP (2013). Practical Manual of Biochemistry. 7th edition, CBS Publishers & Distributors

Zoology Major-5

Semester–IV

MJC–5: Cell Biology (Theory) 3Credits

Course out comes:

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

Unit 1: Overview of Cell

Basic structure 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.
3. Cell junctions: Tight junctions, Gap junctions, Desmosomes and Hemidesmosome.

Unit 3: Cytoplasmic organelles

1. Brief idea on Endoplasmic Reticulum, Ribosome, Golgi Apparatus, Lysosomes
2. Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis.
3. 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; Chromosome condensation.

Unit 5: Cell Cycle

1. Spindle apparatus and basic idea of molecular motors; Role of spindle apparatus in chromosome separation.
2. Cell cycle and its regulation.
3. Mitosis and Meiosis: Basic process and their significance

Unit 6: Apoptosis and Cancer

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

Unit 7: Cell Signaling

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

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.andHausman,R.E.(2009).TheCell:AMolecularApproach.5thEdition.ASMPressandSunderland,Washington,D.C.;SinauerAssociates,

MA.Hardin,J.Bertoni,GandKleinsmith,J.L.(2012).Becker'sWorldoftheCell.8thEdn,PearsonBenjaminCummings,SanFrancisco.

Harvey,L.(2004).MolecularCellBiology.5thEdn.W.H.Freeman

Karp,G.(2008).CellandMolecularbiology:ConceptsandApplication.5thEdn,JohnWiley.

Lodish,Berk,Matsudaira,Kaiser,Bretscher,Ploegh,Amon,andMartin(2016)MolecularCellBiology.8thEdn.W.H.Freeman

Plopper,G,D.Sharp,Siroski,E(2015)Lewin'sCell3rdEdition—Johns&BartlettPublishersPollard and Earnshaw (2007).Cell Biology.2nd.EdnSaunders.

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

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

DeRobertis, E.D.P. and DeRobertis, E.M.F.(2006) Cell and Molecular Biology (8thedition) Lippincott Williams and Wilkins, Philadelphia.

MJC-5: Cell Biology (Practical) 1 Credit

Course out comes:
Testicular cells of insects and root tips meristem of onions are used for cell division study with reference to meiosis and mitosis respectively. Thus the incumbents are required to prepare tissues, prepare suitable stains for the use in study, and handle microscopes for the purpose.
In addition to the above experiment the course also includes Barr body study using female cheek epithelium.

Practicals

1. Use of micrometers and Camera Lucida (prism-type) in measuring and drawing of zooplankton
2. Familiarization with the student's light microscope and stereo-binocular microscope; preparation of aceto-orcein/ aceto-carmine 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 **Fullmarks:15**

1. Drawing of zooplankton specimen provided using camera lucida	3 (2+1)
2. Squash preparation, staining and identification of any stage from mitosis or meiosis	5 (3+2)*
3. Preparation of Barr body	3(2+1)*
4. Submission of laboratory notebook:	2
5. Viva	2

*Note:

Q1. Drawing of zooplankton (2 marks, Perfection 1 marks)
Q2.Preparation:3marks;identification and drawing:2 marks
Q3. Preparation: 2 marks and drawing: 1 mark.

Suggested Reading

Gupta R., Makhija S., TotejaR.(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)L

Zoology Major-6

Semester–IV

MJC-6: Animal Physiology: Life Sustaining System 3 Credits

Course out comes:
Life sustaining system of physiology deals with the systems which are essential for the sustenance of life, including digestive, respiratory, circulatory, renal system where as controlling and coordinating systems regulate and coordinate the sesystems. Therefore, with the inclusion of both in the syllabus fulfill the physiology syllabus.

Unit1: Physiology of Digestion
Mechanical and chemical digestion of food along with the role of digestive enzymes; absorption of Carbohydrates, Lipids and Protein.

Unit2: Physiology of Respiration
Mechanism of Respiration, transport of Oxygen and Carbon di oxide in blood, Dissociation curves and the factors influencing it, carbon monoxide poisoning.

Unit3: 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

Unit4: Physiology of Heart
1. 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.

Unit5: Thermoregulation & Osmoregulation
1. Physiological classification of vertebrates based on thermal biology.
2. Osmoregulation in aquatic vertebrates

Unit6: Renal Physiology
1. Mechanism of urine formation.
2. Regulation of acid-base balance.

Reference Books
Gunstream, S.E. (2010). Anatomy and Physiology with integrated study guide. 4th Edn., McGrawHill
Guyton, A.C. & Hall, J.E. (2006). Text book of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd.
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.
Chatterjee C.C. (2020) Human physiology: VOL 1 & 2, 13 ED,CBS publishers.

ZoologyMajor-6

MJC-6 Animal Physiology: Life Sustaining System (Practical) 1 Credit

Course Outcomes:

1. This course teaches to enumerate the red blood cells and to learn total and differential count of white blood cells using haemocytometer.

2. The course also teaches to estimate haemoglobin content using Sahli's haemoglobinometer.

3. Beside these, determination of ABO Blood group, preparation of haemin crystals and recording of blood pressure using a sphygmomanometer are the other important methods of studies included in the syllabus

Practicals

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

Examination Pattern: **Full marks:15**

1.	Experiment (anyone; From Item no.1 or 2):	7[5+2]*
2.	Experiment(anyone; From Item no.3 or 4 or 5):	4[(2+1+1)/(3+1)]*
3.	Submission of laboratory note book:	2
4.	Viva	2

*Note:

Q1.For preparation 5marks and for result 2 marks

Q2.For item no. (3and4): preparation 2 marks and 1 mark each for drawing and labelling. For item no. (5), 3 marks for procedure and 1 mark for result

ZoologyMajor-7

Semester–IV

MJC–7: Developmental Biology (Theory) 3 Credits

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

Unit1: Introduction

1. Basic concepts: Phases of Development

Unit2: Early Embryonic Development

1. Gametogenesis; Spermatogenesis, Oogenesis; Types of eggs, Egg membranes
2. Fertilization (External and Internal), prevention of polyspermy
3. Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques)
4. Early development of frog and chick upto gastrulation
5. Embryonic induction and organizers

Unit3: Late Embryonic Development

1. Fate of Germ Layers (Brief idea)
2. Extra-embryonic membranes in birds.
3. Implantation of embryo in human.
4. Placenta (Structure, types and functions).

Unit4: Post Embryonic Development

1. Development of brain and Eye in Chick.
2. Brief idea of regeneration: Types and examples

Unit5: Implications of Developmental Biology

1. Teratogenesis: Teratogenic agents and their effects on embryonic development
2. Invitro fertilization, Stem cell (ESC)
3. 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, McGrawHill Education
Chattopadhyay, S (2018) An introduction to Developmental biology, 1st Ed, Books & Allied
DeJonge,C.J. and Barratt,CLR (2006).The Sperm a cell. CambridgeUniv 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
Schoenwolf, G.C., Bleyl,S.B., Brauer, P.R. and Francis-West, P.H.(2009). Ladesn's Human Embryology. 4thEdn.Elsvier
Slack JMW(2006). Essential Developmental Biology.2nd Edn. Blackwell Pub.
Shostak, S. (1991). Embryology-An Introduction to Developmental Biology. Harper Collins
Verma and Agarwal. Developmental Biology.S. Chand Pub. New Delhi.
Rastogi,V.B.; (2012) 1st Ed, Chordate Embryology, KedarNath Ram Nath
Wolpert,L.(2002).Principles of Development. 2nd Edn. Oxford Univ. Press
Wolpert, L. (2007) Principles of Developmental Biology (3rd edition). Oxford University Press UK.
Balinsky (2012).Embryology. 5th Ed, Thompson Brooks Cole (India) Pvt. Ltd.

MJC–7: Developmental Biology (Practical) 1 Credit

Course outcomes:
The practical course will enable students to identify developmental stages of chick, developmental stages and lifecycle 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. Identificationofthedevelopmentalstagesandlifecycleof Drosophilafromstockculture
3. Identification of different sections of placenta (epitheliochorial, endotheliochorial and hemochorial) (photomicrograph / slides)
4. Project report on Drosophila culture / chick embryo development
5. Submission of Laboratory Note Book

Distribution of Marks
Examination Pattern **Fullmarks:15**

1. Identification with reasons (any three) (From Item no.1, 2 & 3)	9(3×3)*
2. Project Report (From Item no.4):	2
3. Laboratory note book:	2
4. Viva with special emphasis on Project report	2

***Note:**

Q1. Identification:1mark and reasons**: 2**marks

ZoologyMajor-8

Semester–IV

MJC-8: Evolutionary Biology (Theory) 3 Credits

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

Unit1

1. Origin of life: Evolution of life forms and present status.

Unit2

1. Evolutionary concepts: Lamarckism, Darwinism and Neo Darwinism

Unit3

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

Unit4

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, bottle neck phenomenon).
3. Role of migration and mutation in changing allele frequencies.

Unit5

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

Unit6

1. Basic concept of extinctions: Background and mass extinctions (causes and effects); K-T extinction

Unit7

1. Phylogenetic trees, Convergent, Divergent and Parallel evolution.

Reference Books:

Barton,N.H.,Birggs,D.E.G.,Elsen,J.A.Goldstein,D.B.andPatel,N.H.(2007).Evolution.CSHLPress

Bergstorm,C.T.and Dujatkin, L.A.(2012).Evolution.1stEdn.W.W.NortonandCo.

Campbell,N.A. and ReeceJ.B (2011).Biology.IX Edition.Pearson,

Benjamin,Cummings.DobzhanskyT.,Ayala,F.J.,Stebbins,J.L.&Valentine,J.W.(1977).Evolution.SurajeetPub.,N.

Delhi Douglas, J.Futuyma (1997). Evolutionary Biology. Sinauer Associates.

Freeman,S.,Herron,J.C.(2016).EvolutionaryAnalysis.PearsonEducationLimited,Noida,India.Gillespie,J.H.(19

98).PopulationGenetics:aConciseGuide.JohnHopkinsUnivPress.

Hall,B.K.and Hallgrimson,B.(2008).Stirckberger'sEvolution.4thEdn.JonesandBarlett.

Kardong,K.(2004).An Introduction to Biological Evolution. McGrawHill.

Mitchell,T.N.(2010).ChemicalEvolutionandtheOriginofLife.Springer.

Page,R.D.M.andHolmesE.C.(1998).MolecularEvolution:APhylogeneticApproach.BlackwellSc

Ridley, M. (1996). Evolution. 2nd Edn. Blackwell Science.

RussellP.J.(2016)iGeneics:AMolecularApproach.3rdedition,PearsonEducationIndia

Scientific American Special Issue (2006).Becoming Human: Evolution and the rise of intelligence.

Smith,J.M.(1998).EvolutionaryGenetics.2ndEdn.OxfordUnivPress.15.Volpe,E.P.andRossenbaum,P.A.(1999).Evolution.McGrawHill.

Zoology Major-8

MJC-8: Evolutionary Biology(Practical) 1 Credit

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

Practicals

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

Distribution of Marks

Examination Pattern **Fullmarks: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)	2
4. Submission of laboratory notebook:	2
5. Viva	2

***Note:**
Q1.Identification:1mark and reasons:1marks

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) AnAdvanced LaboratoryManual of Zoology, Laxmi Publications
Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced PracticalZoology

Zoology Major-9

Semester–V

MJC-9: Molecular Biology (Theory) 3 Credit

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

Unit 1: Overview of molecular Biology
1. Emergence, Historical growth of the discipline and scope

Unit 2: DNA Replication
1. Concept of DNA Replication: Semi-conservative, bidirectional, discontinuous.
2. Mechanism of replication in Prokaryotes.
3. Replication of telomeres in Eukaryotes.

Unit 3: Transcription
1. Mechanism of Transcription in prokaryotes.
2. Mechanism of Transcription in eukaryotes and role of Transcription factors.

Unit 4: Translation
1. Genetic code: Properties, Degeneracy of the genetic code and Wobble Hypothesis.
2. Mechanism of protein synthesis in prokaryotes: fidelity of protein synthesis, aminoacyl t-RNA synthetase and charging of t-RNA; Proteins involved in initiation, elongation and termination of polypeptide chain.
3. Inhibitors of protein synthesis.

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA
1. Capping and Poly-A tail formation in mRNA.
2. Split genes: concept of introns and exons, splicing mechanism, alternative splicing and differential gene expression.
3. RNA editing

Unit 6: Gene Regulation
1. Regulation of Transcription in prokaryotes: lac operon and trp operon.
2. Regulation of Transcription in eukaryotes: Activators, enhancers, silencer, repressors, mi RNA mediated gene silencing, genomic imprinting.

Unit 7: DNA Repair Mechanisms
1. Types of DNA repair mechanisms: Nucleotide and base excision repair; SOS repair.

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 CellBiology.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)MolecularCellBiology.8thEdn.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,Mc Lennan, 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.

ZoologyMajor-9

MJC-9: Molecular Biology (Practical) 1 Credit

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

Practicals

1. Study and interpretation of electron micrograph / photograph showing
   a. Lampbrush chromosome
   b. DNA replication
   c. Transcription
   d. Split gene
2. Preparation of Polytene chromosome from Chironomus or Drosophila larva
3. Instruments and accessories used to be shown by photographs for the following techniques: PCR, SDS PAGE, Western Blot, Southern Blot
4. Submission of Laboratory Note Book

Distribution of Marks

Examination Pattern:	**Fullmarks:15**
1. Identification with reasons (any two; FromItemno.1)	4(2×2)*
2. Preparation of Polytene chromosome (Itemno2)	7(5+1+1)*
3. Submission of laboratory note book:	2
4. Viva-voce	2

*Note:

Q1.Identification:1mark and reasons: 1 marks

Q2.Preparation: 5 marks and drawing and labelling: 1mark each

ZoologyMajor-10

Semester–V

MJC-10: Genetics (Theory) 3 Credit

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

Unit 1: Mendelian Genetics and its Extension
1. History of Genetics and its scope
2. Mendel's Theory of inheritance: Multiple alleles; Lethal alleles; Epistasis; Pleiotropy; sex- linked, sex-influenced and sex-limited inheritance; Polygenic Inheritance.
3. Cytoplasmic inheritance: Kappa particle in *Paramoecium*; Shell spiralling in snail

Unit 2: Linkage, Crossing Over and Chromosomal Mapping
1. Linkage and Crossing Over: Molecular basis of crossing over (Holiday model)
2. Measuring recombination frequency and linkage intensity using three-factor crosses; Interference and coincidence.

Unit 3: Mutations
1. Types of gene mutations (Classification).
2. Types of chromosomal aberrations (Classification with one suitable example of each).
3. 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.

Unit 5: Drosophila Genetics
1. Differential gene expression in pattern formation of *Drosophila* with special reference to dorso-ventral axis.
2. Genetic basis of eye colour and bar eye in *Drosophila.*

Unit 6: Transposable Genetic Elements
1. Basic idea of Transposable mechanism.
2. Transposable elements in Bacteria.
3. Ac-Ds elements in maize; P-element in *Drosophila*.
4. Retroposons: LINEs, SINEs, Alu elements in humans

Reference Books

Brooker, R. J. (2012). Genetics Analysis and Principles .4th Edn. McGrawHill.
Dale, J.W. and Park, S. F. (2004). Molecular Genetics of Bacteria. 4th 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.
Pierce, B.A.(2013).Genetics Essentials: Concepts and Connections. 2nd Edn.Freeman
W.H. Russell, P.J. (2009).Genetics-A Molecular Approach. III Edition.
Scott.F. Gilbert (2010) Developmental biology,9th edition, Sinauer Associates Inc Snustad,
D.P. Simmons, M.J. (2009). Principles of Genetics.V Edition. JohnWiley and SonsInc
Tamarin, R.F (1998). Principles of Genetics. William C Brown Pub
Verma P S, Agarwal V K (2016). Genetics, 9th edition. S.Chand and Company Pvt. Ltd

ZoologyMajor-10

MJC-10: Genetics (Practical) 1 Credit

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

Practicals

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

Distribution of Marks

Examination Pattern	Full marks: 15
1. Identification with reasons (any two; From Item no.1 & 4)	4(2×2)*
2. Any one problem (From Item no.2 or 3):	7
3. Submission of laboratory note book:	2
4. Viva-voce	2

*Note:

Q1.Identification:1mark for reasons:1 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

Semester–V

ZoologyMajor-11

MJC-11: Animal Behaviour and Chronobiology (Theory) 3 Credit

Course outcomes:

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

Unit 1: Introduction to Animal Behaviour

1. Origin and history of Ethology.
2. Proximate and ultimate causes of behaviour.

Unit 2: Patterns of Behaviour

1. Stereotyped Behaviours (Orientation, Reflexes).
2. Individual Behavioural patterns: Instinct vs. Learned Behaviour; Habituation, Imprinting.

Unit 3: Social and Sexual Behaviour

1. Social Behaviour: Concept of Society; various modes of animal communication.
2. Altruism: Insects' society with Honey bee as an example; Foraging in honey bee and bee dance.
3. Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (femalechoice), Sexual conflict in parental care.

Unit 4: Biological Rhythm

1. Types and characteristics of biological rhythms: Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Circannual rhythms
2. Concept of synchronization and masking; Photic and non-photic zeitgebers.
3. Photoperiod and regulation of seasonal reproduction of vertebrates: Role of melatonin and serotonin.
4. Adaptive Significance of Biological Clock.

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 Time keeping, 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.

ZoologyMajor-11

MJC-11: Animal Behaviour and Chronobiology (Practical) 1 Credit

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

Practicals

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

Distribution of Marks

Examination Pattern **Fullmarks:15**

1.One experiment (From 3 or 4)	3
2.Project report (any one from item no.1 or 2)	4
3.Report on excursion (Item 6)	4
4.Laboratory notebook	2
5. Viva-voce based on project work and Excursion	2

Semester–V

Zoology Major-12

MJC-12: Endocrinology (Theory) 3 Credit

Course out comes:

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.

Unit1: Introduction to Endocrinology

1. General idea of Endocrine systems, Classification of Hormones.

Unit2: 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 neuro endocrine glands, Feedback mechanisms.
3. Structure of pituitary gland, its hormones and their functions, Hypothalamo-hypophysial portal system.

Unit3: 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.

Unit4: Regulation of Hormone Action

1. Mechanism of action of steroidal, non-steroidal hormones with receptors.

Reference Books

David O Norris (2013) Vertebrate Endocrinology, Elsevier

Fox T., Brooks, A. and Baidya,B.(2015). Endocrinology. J P Medical, London.

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

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

Hall John E. (2015) Guyton and Hall Text book of Medical Physiology.13thEdition

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.4thEdn. McGrawHill 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

Zoology Major-12

MJC-12: Endocrinology (Practical) 1 Credit

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

Practical

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 endocrine glands.
4. Submission of laboratory Note Book.

Distribution of Marks

Examination Pattern	Full marks:15
1. Identification with reasons (any two) (FromItemno.2)	4(2×2)*
2. Microtomy (Tissue sectioning/staining) (From item 3)	5
3. Submission of permanent slide (any two mammalian endocrine tissue)	2
4. Submission of laboratory note book:	2
5. Viva-voce	2

*Note

Q1.½ 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 J D, Gamble M (2008) Theory and practice of histological techniques.6th edition, Elsevier Publication

Semester–VI

Zoology Major-13

MJC-13: Immunology (Theory) 3 Credit

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

Unit 1: Overview of Immune System
1. Basic concepts of health and diseases.
2. Brief idea of lymphoid organs.

Unit 2: Innate and Adaptive Immunity
1. Components of innate immunity; Inflammation.
2. Cell and molecules involved in Adaptive immunity (Cell mediated and humoral).

Unit 3: Antigens
1. Antigenicity and immunogenicity, Immunogens.
2. Adjuvants and haptens, Factors influencing immunogenicity.
3. B and T-Cell epitopes.

Unit 4: Immunoglobulins
1. Structure and functions of major classes of immunoglobulins.
2. Antigen- antibody interactions,
3. Hybridoma technique, concept of monoclonal antibody

Unit 5: Major Histocompatibility Complex
1. Structure and functions of MHC molecules.
2. Structure of T cell Receptor and it's signaling.

Unit 6: Cytokines
1. Types, properties and functions of cytokines.

Unit 7: Complement System
1. Components and pathways of complement activation.

Unit 8: Hypersensitivity
1. Gell and Coombs' classification and brief description of various types of hypersensitivities.

Unit 9: Vaccines
1. 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 ofMicrobiology and Immunology.2nd Edn. Elsevier.
Playfair, JHL and Chain, BM (2001) Immunology at a glance. 7th Edn. Blackwell Pub.
Shetty,N. (2005). Immunology: Introductory Textbook. 2nd Edn. , New Age Internatl. Pub.N.Delhi
Virella, G(2007).Medical Immunology 6th Edn. Informa Healthcare

Zoology Major-13

MJC-13: Immunology (Practical) 1 Credit

Course Outcomes:

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

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

Examination Pattern:	**Fullmarks:15**
1. Identification with reasons (any two; From Item no. 1 & 2)	4(2+2)*
2. Preparation of stained blood film [from item 3]	4(2+1+1)*
3. Experiment (any one; From Item no.4):	3(2+1)*
4. Laboratory notebook:	2
5. Viva voce	2

*Note:

Q1.Identification:½ mark and reasons: 1½marks

Q2. 2 marks for preparation and 1 mark each for identification and drawing

Q3. Experiment: 2 marks and result: 1 mark

Semester–VI

Zoology Major-14

MJC-14: Biology of Insecta (Theory) 3 Credit

Course outcomes:
The will enable students to study Insect Taxonomy, insect classification; general morphology of insects, physiology of insects, photoreceptors structure and function, insect Plant Interaction etc.

Unit 1: Introduction
1. General Features of Insects
2. Success of Insects on the Earth
3. Role of insect in human welfare

Unit 2: Insect Taxonomy
1. 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

Unit 5: Insect Society
1. Bee Dance: Round Dance and Waggle Dance
2. Trophallaxis in social insects such as ants

Unit 6: Insect Plant Interaction
1. Theory of co-evolution; role of allelochemicals in host plant mediation; Host-plant selection by phytophagous insects

Unit 7: Insects as Vectors
1. Brief discussion on Diptera as a carrier of disease and control

Reference Books
1. Bernays, E. A., and Chapman, R. F. (1994).Host Selection by Phytophagous insects, , Chapman and Hall, New York, USA
2. Borror, D. J., Triplehorn, C. A., and Johnson, N. F. M (1989) Introduction to the study of insects Saunders College Publication, USA
3. Chandra G (2000) Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA Mosquito, Sribhumi Pub. Co.
4. Chapman, R. F (2012) The Insects: Structure and function, Cambridge University Press, UK Gullan P J and Cranston, PS (2000)
5. The Insects, An outline of Entomology, Wiley Blackwell, UK Hati A. K (2010) Medical Entomology, Allied Book Agency,
6. Imms A D Richards, O.W., Davies, R.G. (1977) Imms' general text book of entomology, Springer Netherlands Klowden, M. J (2013) 7. Physiological system in Insects, Academic Press, USA
9. Snodgrass, R. E. (2004) Principles of Insect Morphology, Cornell Univ. Press, USA Wilson, EO (1971) The Insect Societies, Harward Univ. Press, UK

ZoologyMajor-14

MJC-14: Biology of Insecta (Practical) 1 Credit

Course outcomes:

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

Distribution of Marks

Examination Pattern	**Full marks: 15**
1. Spot identification with economic importance (any 2; one from each Item no.6 & 7)	3 (1.5×2)*
2. Identification with reason (any two, from 1 and 2)	4 (2×2)*
3. Mounting (anyone from Item no. 3)	2
4. Project report (any one from Item 5)	2
5. Submission of laboratory note book:	2
6. Viva-Voce	2

*Note

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

Q2. ½ mark for identification and 1½ mark for reasons.

Semester–VI

Zoology Major-15

MJC-15:Parasitology (Theory) 3 Credit

Course outcomes:

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

Unit 1: Introduction to Parasitology

1. Brief introduction of Parasitism: Parasite, Host, Parasitoid and Vectors (mechanical and biological vector).
2. Host parasite relationship

Unit 2: Parasitic Protozoans

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

Unit 3: Parasitic Platyhelminthes

1. Study of *Schistosoma haematobium, Taenia solium* : Morphology, Life Cycle, Epidemiology, Pathogenicity and control

Unit 4: Parasitic Nematodes

1. Study of *Ascaris lumbricoides* and *Ancylostoma duodenale* : Morphology, Life Cycle, Epidemiology, Pathogenicity and control
2. Nematode plant interaction; Gall formation

Unit 5: Parasitic Arthropods

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

Unit 6: Parasitic Vertebrates

1. Brief account of 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, 4th 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

Zoology Major-15

MJC-15: Parasitology (Practical) 1 Credit

Course outcomes:

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

1. Identification of life cycle stages of *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. Preparations and Identifications of Protozoan Parasites from Seminal Vesicle of Earthworm / digestive tract of cockroach
7. Submission of a brief report on any parasite on vertebrates
8. Submission of Laboratory Note Book

Distribution of Marks

Examination Pattern	**Full marks: 15**
1. Identification with reasons (any three) (From Item 1, 2, 3, 4,5)	6 (2×3)*
2. Experiment from Item Number 6	3 [2+1]*
3. Project Report (Item 7)	2
4.Submission of laboratory note book	2
5. Viva-Voce with special emphasis on project report	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 Preparation2 marks and 1 mark each for drawing and labelling

Semester–VI

Zoology Major-16

MJC-16: Microbiology (Theory) 3 Credit

Course outcomes:

The course on Microbiology provides students with a comprehensive understanding of microbial diversity, ecology, structure, and genetics. It equips students with knowledge of microbial interactions, diseases, and their roles in health, medicine, and environmental processes

Unit I: Introduction to Microbiology

1. History and scope of Microbiology
2. Contributions of Leeuwenhoek, Pasteur, Koch, Jenner

Unit 2: Bacteriology

1. Morphology and structure of Gram-positive and Gram-negative Bacteria, Brief Idea of Bacterial Plasmid.
2. Control of microbes: Physical and chemical methods

Unit 3: Virology

1. Structure and classification of viruses.
2. Bacteriophages and their life cycle (Molecular Mechanism of Lytic & Lysogeny)
3. Prions and Viroids

Unit 4: Medical Microbiology

1. Bacterial and viral diseases (Tuberculosis, Cholera, Influenza, COVID-19, Dengue) Mode of transmission, symptoms, pathogenicity and prevention.
2. Sexually transmitted diseases- AIDS and Gonorrhea
3. Role of microbiology in vaccines and antibiotics.

Unit 5: Microbial Genetics

1. Conjugation, Transformation, Transduction, Complementation test in Bacteriophage.

Unit 6: Introduction to Industrial Microbiology

1. Role of microorganisms in Industry: Brief idea
2. Microbes in Diary Industry: basic concept
3. Microbial production of Biofuels

Suggested Readings:

1. Prescott, Harley & Klein. Microbiology
2. Pelczar, Reid & Chan. Microbiology
3. Madigan, Martinko & Stahl. Brock Biology of Microorganisms
4. Willey, Sherwood & Woolverton. Prescott's Microbiology

Zoology Major-16

MJC-16: Microbiology (Practical) 1 Credit

Course outcomes:

Students will acquire hands-on experience in core microbiological techniques such as Gram staining, bacterial culturing through the streal method, and identification of bacteria and viruses using photomicrographs. They will explore microbial physiology through project work on bact life cycles, perform yeast fermentation to study alcohol production from sugar, and conduct microbiological analysis of milk using the Methy Blue Reduction Test. These practical skills will enhance their ability to identify, handle, and evaluate microorganisms, preparing them for advar studies and applications in medical, food, and industrial microbiology.

1. Identifications of Bacteriophage, TMV, HIV, *E. coli, Streptococcus* sp., *Vibrio*, & SARS-CoV-2, *Rhizopus*, *Penicillium*. (From Electron Micrograph)

2. Gram staining technique of Bacteria using curd sample.

3. Microbiological examination of Milk (Methylene blue reduction test)

4. Preparation of solid culture media (LB)and growth of E.coli by spreading and Streaking methods

5. Submission of a project report on role of microbes in human welfare.

6.. Submission of Laboratory Note Book

Distribution of Marks

Examination Pattern	**Full marks: 15**
1. Identification with reasons (any three) (From Item 1)	6 (2×3)
2. Experiment from Item Number 2 or 3.	3 [2+1]
3. Project Report (Item 5)	2
4.Submission of laboratory note book	2
5. Viva-Voce with special emphasis on project report	2

Semester-I

Zoology Minor-1

MN-1:NonChordate (Theory) 3 Credits

Unit1: Introduction

Coelom: Types, Evolution and significance

Unit 2: 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)

Unit 3: Protista

Protozoa:

General characteristics and classification upto phylum (Levineet.al., 1981)

Locomotion in Protozoa with special reference to *Euglena, Paramoecium* and *Amoeba*; Conjugation in *Paramoecium.*

Unit 4: Porifera

1. General characteristics and classification upto Classes (Hyman 1940)
2. .Canal system and spicules in sponges

Unit 5: Cnidaria

1. General characteristics and classification upto classes
2. Metagenesis in *Obelia*
3. Corals and coral reef diversity, function & conservation

Unit 6: Platyhelminthes

General characteristics and classification upto classes

Unit 7: Nematoda

1. General characteristics and classification upto classes
2. Parasitic adaptations in helminthes

Unit 8: Annelida

1. General characteristics and classification upto classes
2. Reproduction in earthworm.

Unit 9: Arthropoda

1. General characteristics and classification upto classes
2. Social life in termite
3. Insect Metamorphosis

Unit 10: Onychophora

General characteristics and Evolutionary significance of *Peripatus*

Unit 11: Mollusca

1. General characteristics and Classification upto classes
2. Nervous system and torsion in Gastropoda

Unit12: Echinodermata

1. General characteristics and Classification upto classes
2. Water-vascular system in *Asterias*

Unit 13: Hemichordata

1. General characteristics of phylum Hemichordata.
2. Evolutionary significance of Hemichordates

Note: Classification to be followed from Barnes and Ruppert 1994, 6thEdition

Reference Books

Barnes, R.D. & Ruppert, E.E., (1994). Invertebrate Zoology. 6th Ed. Brooks Cole
Brusca, R.C.& Brusca, G.J. (2002). Invertebrates.4thEd.Sinauer Associates

Mandal FB (2015), Human Parasitology 2ndEdition, PHI Learning
Kapoor,V.C. (2008). Theory and practice of animal taxonomy. 6th Ed. Oxford & IBH Pub
Mayr, E. (1969).Principles of Systematic Zoology. TataMcGraw-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 InternationalEdition.
Sinha,K.S., Adhikari,S., & Ganguly, B.B. Biology of Animals.Vol.I. New Central Book Agency.Kolkata

MN-1:NonChordate (Practical) 1 Credit

Practicals

1. Identification of following specimen
   Amoeba, Euglena, Paramecium, Sycon, Fasciola, Ascaris, Physalia, Aurelia, Gorgonia, Metridium, Pennatula, Fungia, Aphrodite, Pheretima, Hirudinaria, Balanus, Eupagurus, Scolopendra, Peripatus. Chiton, Pinctada, Octopus, Nautilus, Asterias, Balanoglossus
2. Identification of T.S. through pharynx, gizzard and typhlosolar intestine of earthworm
3. Dissection of digestive system and nervous system of earthworm
4. Dissection of reproductive system of earthworm
5. Dissection: digestive system and nervous system of Cockroach
6. a. Mounting of mouth parts of Cockroach
   b. Staining and mounting of any protozoa / helminth from gut of cockroach.
7. Submission of Laboratory Note Book

Distribution of Marks

Examination Pattern:	**Fullmarks:15**
1. Identification with reasons (any three):	6(3x2)*
2. Dissection (any one) (From Item no. 3, 4 and 5)	3(2+1)
3. Staining / Mounting (anyone) (From Item no. 6):	4(2+1+1)
4. Laboratory Notebook	2

***Note:**
Q1.For Item (1), Sc. name: 0.5 mark, Systematic Position 0.5 and Reasons:1marks.
For Item (2)1mark is allotted for both identification and characters.

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

Semester-II

Zoology Minor-2

MN-2:Chordate and Comparative Anatomy (Theory) 3 Credits

Group A

Unit 1: Introduction to Chordates

Origin of Chordate (Dipleurula concept and the Echinoderm theory)

Unit 2: Urochordata and Cephalochordata

1. General characteristics and classification of Urochordata and Cephalochordata upto Classes.
2. Retrogressive metamorphosis in *Ascidia*.

Unit 3: Agnatha

General characteristics and classification of cyclostomes upto order

Unit 4: Pisces

1. General characteristics and classification of Chondrichthyes and Osteichthyes upto Subclasses
2. Migration in fishes
3. Structure and function of Swim bladder

Unit 5: Amphibia

1. General characteristics and classification upto living Orders.
2. Parental care in Amphibia

Unit 6: Reptilia

1. General characteristics and classification upto living Orders.
2. Poison apparatus and biting mechanism in snakes

Unit 7: Aves

1. General characteristics and classification upto Sub-Classes
2. Migration in birds
3. Aerodynamics of flight

Unit 8:Mammals

4. General characters and classification upto living orders
5. Affinities and phylogeny of Monotremata
6. Echolocation in microchiropterans

GROUPB

Unit 9: Integumentary System

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

Unit10: General idea of Axial and appendicular Skeleton

Unit 11:Digestive System

Ruminating stomach; dentition in mammals

Unit12: Respiratory System

Respiratory organs in fish, amphibian, and birds

Unit 13: Circulatory System

Comparative account of heart and aortic arches

Unit 14: Urinogenital System
Archinephros, Pronephros, Mesonephros and Metanephros Evolution of urinogenital ducts,

Unit 15: Nervous System
Comparative account of brain, Cranial nerves in mammals

Unit 16: Sense Organs
Classification of receptors

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 PubCo.
Futuyama, D. (1997). EvolutionaryBiology.3rdEd. Sinauer Associates, INC.
Hall B.K. and Hall grimsson 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. NewDelhi.
Kardong, K.V. (2002).Vertebrates: Comparative anatomy, function evolution.Tata McGrawHill.
Kent, G.C. & Carr,R. K.(2001). Comparative anatomy of the Vertebrates .9th Ed. McGrawHill.
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.& Bharati Goswami,B.D. (2001). Biology of Animals. Vol.II .New Central Book Agency (p) Ltd.
Young,J.Z.(2004). The Life of Vertebrates. Ill Edition. Oxford university press.
Kardong,K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education
Kent, G.C. and CarrR.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.

MN-2: Chordate and Comparative Anatomy (Practical) 1Credit

Practicals

1. .Identification of following specimen
Branchiostoma, Petromyzon ,Scoliodon, Torpedo, Heteropneustes, Exocoetus, Hippocampus, Necturus, Bufo, Tylototriton, *Chelone, Chamaeleon, Draco, Vipera, Naja, Alcedo, Psittacula. Pteropus*, *Funambulus*,
2. Identification of disarticulated skeleton of Pigeon and Guineapig [Skull, Vertebrae (Atlas, Axis) and Pectoral girdle, Pelvic girdle],
3. Mounting of Pecten from Fowl head
4. Staining and mounting of Placoid, Cycloid and Ctenoid scales
5. Dissect out brain of carp
6. Dissection: Afferent branchial arterial system and IX and Xthcranial nerves of carp
7. Submission of Laboratory NoteBook

Distribution of Marks

Examination Pattern:	**Fullmarks: 15**
1. Identification with reasons (any three;)	6(2+2+2)*
2. Mounting and staining	2
3. Dissection	5(3+1+1)*
4. Submission of laboratory notebook:	2

Semester-III

ZoologyMinor-3

MN-3:Physiology and Biochemistry (Theory) 3 Credits

Course outcomes:
This course provides knowledge on basic principles of physiology and biochemistry including digestion, excretion, reproduction, neuroscience, metabolism as well as the basic understanding of enzyme function.

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

Unit 2: Respiration
Pulmonary ventilation, Respiratory volumes and capacities,

Unit 3: Cardio-vascular 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 neuron, resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle,

Unit 6: Reproduction and Endocrine Glands
Physiology of female reproduction: hormonal control of menstrual cycle. Structure and function of Pituitary, Thyroid, Pancreas and Adrenal gland

Unit 7: Carbohydrate Metabolism
Glycolysis, Krebs Cycle, Gluconeogenesis,

Unit 8: Lipid Metabolism
β oxidation of palmitic acid

Unit 9: Protein metabolism
Transamination, Deamination

Unit10: Enzymes
Classification, Mechanism of action,

Reference Books

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 Text book 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). Text book of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B.SaundersCompany
5. Murray, R. K., Granner, D.K., Mayes, P.A. and Rodwell,V.W. (2009). Harper's Illustrated 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, NewDelhi
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.

MN-3: Physiology and Biochemistry (Practical) 1 Credit

Course 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, as well as estimation of enzymatic activity.

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 liver, lung, kidney, testis, ovary
4. Qualitative tests for Glucose (Benedict's test) and Starch (Iodine test)
5. Effect of temperature on the enzymatic activity of amylase by salivary amylase / fungal diastase
6. Submission of Laboratory Note Book

Distribution of marks	**Full Marks:15**
1. One question on Qualitative test (Item No. 4)	04
2. One Experiment (From Item no.1or 5)	03
4. Identification of histological section[(From Item No.2 and 3) any three	(3x2)=06
5. Laboratory Note Book	02

Note:
Q1.Principle1 marks and result 3 marks
Q2.Principle1marks and result 2marks
Q3.½ marks for identificationand1½markforreasons 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

Semester-IV

ZoologyMinor-4

MN-4:Genetics and Evolution (Theory) 3 Credits

Course outcomes:
The course provides basic knowledge of Genetics and Evolutionary Biology including principles of inheritance, extension of Mendelian Genetics, Linkage, Crossing Over and Chromosomal Mapping, Mutations, Sex Determination, Geological time scale, Lamarckism, Darwinism, Neo-Darwinism and Modern Synthetic Theory

Unit 1: Introduction to Genetics
Principles of Inheritance.

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

Unit 5: Sex Determination
Chromosomal mechanisms in *Drosophila*.

Unit 6: Introduction to Evolution
Macro-evolutionary Principles (example: Darwin's Finches); Basic understanding of Micro-evolution, Origin of Life, Overview of Geological time scale, Convergent and divergent evolution

Unit7: Introduction to Evolutionary Theories
Lamarckism, Darwinism, Neo-Darwinism, Modern Synthetic Theory

Unit 8: **Processes of Evolutionary Change**
Speciation; Isolating Mechanisms; Modes of speciation (Allopatric, Sympatric) Natural selection: types (Directional, Stabilizing, Disruptive),

Unit 9: Species Concept
Biological,Typological and Evolutionary species concept (Advantages and Limitations)

Suggested reading:

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).Genetics LAnalysis and Principles.4thEdn.McGrawHill.
3. Chattopadhyay,S. (2012). Life: Evolution, Adaptation,Ethology.3rdEdn.BooksandAllied,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. and Carroll,S.B.(2010). Introduction to Genetic Analysis WH Freeman.
7. Hall, B.K. and Hallgrimsson, B. (2008). Evolution. IVEdition. Jones and Bartlett Publishers
8. Hyde,D.(2009). Introduction to Genetic Principle. McGrawHill.
9. Kardong,K.(2004). An Introduction to Biological Evolution. McGrawHill.
10. Klug,W.S.,Cummings, M.R.,Spencer,C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
11. Pierce,B.A. (2013). Genetics Essentials: Concepts and Connections. 2nd 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. JohnWiley and Sons Inc.

MN-4: Genetics and Evolution (Practical) 1 Credit

Course outcomes:
This course will enable students to identify major group of fossils from models / photographs, Normal karyotype of man, as well as karyotypes in Down, Klinefelter's, Turner, Cri -du-Chat syndromes. Chi square test is taught to verify different experimental results

List of Practicals

1. Identification of major group of fossils from models/pictures (Petrified fossil, moulds, casts, carbon film, trace fossil)
2. Identification of Human Karyotypes (Normal karyotype, Down, Kline felter'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 (NonMendelian Inheritance) using suitable examples. Verify the results using Chi-square test
6. Submission of Laboratory NoteBook

Distribution of marks **FullMarks:15**

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

Note
Q1 .½ mark for identification and 1½ marks for reasons

Semester-V

Zoology Minor-5

MN-5: Cell and Molecular Biology (Theory) 3Credits

Unit 1: Overview of Cell
1. Basic structure 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.

Unit 3: Cytoplasmic organelles
1. Structure and Functions: Endoplasmic Reticulum, Ribosome, Golgi Apparatus, Lysosomes, Mitochondria, Centrosome.

Unit 4: Nucleus
1. Chromatin: Euchromatin and Hetrochromatin.
2. DNA packaging.

Unit 5: Cell Cycle
1. Cell cycle and its regulation.
2. Mitosis and Meiosis: Basic process and their significance.

Unit 6: Cancer
1. Cancer: Types of Cancer, Characters of Transformed cells.
2. Genetic basis of cancer: Brief idea of Proto-oncogene and tumor suppressor gene.

Unit 7: DNA Replication
1. Concept of DNA Replication: Semi-conservative nature, Mechanism of replication in Prokaryotes.

Unit 8: Transcription
1. Mechanism of Transcription in prokaryotes.

Unit 9: Translation
1. Genetic code: Properties
2. Mechanism of protein synthesis in prokaryotes.

Unit 10: Gene Regulation
1. Regulation of Transcription in prokaryotes: lac operon

Zoology Minor-5

MN-5:Cell and Molecular Biology (Practical) 1Credits

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Preparation and identification of various stages of meiosis from grasshopper testis.
3. Study and interpretation of electron micrograph/photograph showing

a. Lamp brush chromosome

b. DNA replication

c. Transcription

d. Split gene

Distribution of Marks

Examination Pattern:	**Full marks: 15**
1. Identification of any four from item no 1 (mitotic stages) and 3:	8 (4x2)*
2. Squash preparation, staining and identification of any stage from mitosis or meiosis	5 (3+2)*

3.. Submission of laboratory note book:

***Note:**
Q1. Identification of the stage: 1 mark and characters: 1marks
Q2. Preparation: 3 marks; identification and drawing: 4 marks

Suggested Reading

Gupta R., Makhija S., Toteja R. (2018) Cell Biology : Practical Manual Paperback, Prestige Publishers Ghosh, K.C. and Manna, B. (2015): Practical Zoology, New Central Book Agency, Kolkata
Poddar T. K., S. Mukherjee & S. K. Das (2002) An Advanced Laboratory Manual of Zoology, Laxmi Publications Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books and Allied (P) Ltd

Semester-VI

Zoology Minor-6

MN-6: Parasitology and Vector Biology (Theory) 3 Credits

Unit 1: Introduction to Parasitology

1. Brief introduction of Parasitism: Parasite (types), Parasitoid.

2. Host: Primary, secondary, reservoir host.

Unit 2: Parasitic Protozoa

1. Study of *Plasmodium vivax* : Morphology, Life Cycle, Epidemiology, Pathogenicity, and control

Unit 3: Parasitic Platyhelminth

1. Study of *Taenia solium*: Morphology, Life Cycle, Epidemiology, Pathogenicity and control

Unit 4: Parasitic Nematode

1. Study of *Wuchereria bancrofti*: Morphology, Life Cycle, Epidemiology, Pathogenicity and control

Unit 5: Concept of Vectors

1. Brief introduction to Vectors (mechanical and biological vectors).

2. Adaptations as vectors.

Unit 6: Insects as Vectors

1. General features of insect and orders with insects as vectors - Diptera, Siphonaptera, Siphunculata, Hemiptera.

Unit 7: Dipteran as Disease Vectors

1. Mosquitoes, Sand fly, Houseflies as important vectors and their control

Unit 8**: Siphonaptera as Disease Vectors**

1. Fleas as important insect vectors and their control

Reference Books

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

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

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

Chandra G (2000). Mosquito, Sribhumi Publication Co. Kolkata

Hati A. K Medical Entomology, Allied Book Agency, Kolkata.

Zoology Minor-6

MN-6: Parasitology and Vector Biology (Practical) 1 Credits

1. Identification of following insect vectors through permanent slides/ photographs: *Aedes, Culex, Anopheles, Pediculus, Cimex, Phlebotomus, Musca.*
2. Identification of following insect parasites through permanent slides/ photographs: *Plasmodium, Entamoeba, Taenia, Fasciola Ascaris, Wuchereria.*
3. Mounting of different kinds of mouth parts of insects (Mosquito/Cockroach).
4. Preparations and Identifications of Protozoan Parasites from Seminal Vesicle of Earthworm / Digestive tract of Cockroach

Distribution of Marks

Examination Pattern	**Full marks: 15**
1. Identification with reasons (any four) (From Item 1 and 2)	8 (2×4)*
2. Temporary mount preparation. (From Item 3 or 4)	5 [3+1+1]*
3.Submission of laboratory note book	2

***Note**

Q1. Maximum 1 from each group. ½ mark for identification, ½ mark for systematic position and 1 mark for characters. only genus characters have to be mentioned.

Q2. For mount preparation3 marks and 1 mark each for drawing and labelling.

Semester-I

Zoology Skill Enhancement Courses (SEC-1)

SEC-1: Sericulture (Theory) 3 Credits

Unit1: Introduction

Sericulture: Definition, history and present status; Silk route
Types of silk worms,
Distribution and Races, Exotic and indigenous races
Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm

Lifecycle 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,
Silk worm rearing technology: Early age and Late age rearing
Types of mountages
Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases

Pests of silk worm: Uzifly, 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 any sericulture centre.

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 diseaseofSilkworm,1956,Ptd.ByDirector 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,FuziPub.Co.Ltd.,Tokyo,Japan1972.
Manual of Silkworm Egg Production; M.N. Narasimhanna, CSB, Bangalore1988.
Silkworm Rearing;Wupang—Chun and Chen Da-Chung, Pub.ByFAO,Rome1988.
A Guide for Bivoltine Sericulture; K.Sengupta,Director,CSR&TI,Mysore1989.
Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore,1986

Semester-II

Zoology Skill Enhancement Courses (SEC-2)

SEC-2Aquarium Fish Management (Theory) 3 Credits

Course outcomes:
The course extends to gain knowledge on exotic and endemic species of Aquarium fishes, biology of aquarium fishes, food and feeding of Aquarium fishes, Fish transportation and maintenance of Aquarium

Unit 1: Introduction to Aquarium Fish Keeping
The potential scope of Aquarium Fish Industry as a Cottage Industry Exotic and Endemic species of Aquarium Fishes, Setting of freshwater aquarium

Unit 2: Biology of Aquarium Fishes
Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Swordtail, Goldfish, Angel fish, Bluemorph, 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

Semester-III

Zoology Skill Enhancement Courses (SEC-3)

SEC-3: Economic Zoology 3 Credits

Course outcomes:
This 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.

Unit1: Agricultural Entomology
Pest-definition and types (major and minor pests with example).
Study of lifecycle, nature of damage and control of paddy Pest (*Scirpopha gaincertulus)*, stored house pest (*Sitophilus oryzae*); Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM).

Unit2: Apiculture
Various domesticated species of Honeybee; Social organization of Honeybee; Bee keeping: Langstroth Box for rearing of honey bee, Extraction and processing of honey; Composition of honey, apiculture by products and their uses; Pests and Diseases of bees and their control measures

Unit3: Vermiculture
Scope of Vermiculture; Habit categories of earthworms; methodology of vermicomposting: containers for culturing, raw materials required, preparation of bed, environmental prerequisites, feeding, harvesting and storage of vermicompost; Advantages of vermicomposting; Diseases and pests of earthworms.

Unit 4: Live Stock Management
Dairy: Introduction to common dairy animals: Types of Cattle breeds and their distribution in India; Exotic cattle breeds; Artificial insemination in Cattle breeding; dairy by products, preservation and uses.
Poultry: Types of breeds (fowl) with features and examples; Rearing method: Deep litter system; poultry byproducts with economic importance; Diseases of poultry and their control measures.

Unit 5:Entrepreneur ship in Economic Zoology
Economic Zoology as a source of employment and livelihood –visit to a farm.

Reference Books

Atwal, A.S. & Dhaliwal,G.S.(2002). Agricultural pests of South Asia and their management. Kalyani Publishers,NewDelhi.
Dent, D. (2000). Insect Pest Management. 2nd Ed. CABI.
Hill,D.S. (1994). Agricultural Entomology. Timber Press.
Hill,D.S. (2008). Pests of Crops in Warmer Climates and their Control. Springer.
Metcalf, R.L. & Luckmann,W. H. (1994). Introduction to Insect Pest Management.3rdEd.JohnWiley&Sons,Inc. Pedigo, L. P. & Rice E. M. (2009). Entomology and Pest Management. 6thEd. PHI Learning Pvt. Ltd.
Ahsan,J. & Sinha,S.P.(2009). A Handbook on Economic Zoology. S. Chand & Company Ltd.
Shukla, G. S. & Upadhyay, V. B. (1998). Economic Zoology. 4th Ed. Rastogi Publication.

Zoology Multidisciplinary Paper-1

Semester-I

MD-1: Sericulture and Silk Production Technology (Theory) 3 Credits

Unit 1: Introduction

Sericulture: Definition, history and present status: Silk route

Types of silkworms, Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silk worm

Lifecycle of *Bombyx mori*

Structure of silk gland, Composition of Silk and secretion of silk

Unit 3: Rearing of Silk worms

Selectionof mulberry variety and establishment of mulberry garden

Rearing house and rearing appliances.

Disinfectants: Formalin, bleaching powder,

Types of mountages

Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases

Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial

Unit 5: Entrepreneurship in Sericulture

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture

Reference Books

Manual on Sericulture; Food and Agriculture Organisation, Rome1976

Hand book 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.

Hand book of Silkworm Rearing: Agriculture and Technical Manual-1, FuziPub. Co.Ltd., Tokyo, Japan1972.

Manual of Silkworm Egg Production; M.N. Narasimhanna, CSB, Bangalore 1988.

Silkworm Rearing; Wupang—Chunand Chen Da-Chung, Pub. By FAO, Rome 1988.

A Guide for Bivoltine Sericulture; K.Sengupta, Director, CSR & TI, Mysore 1989.

Improved Method of RearingYoung age silkworm; S.Krishnaswamy, reprinted CSB, Bangalore, 1986

Zoology Multidisciplinary Paper-2

Semester-II

MD-2: Environment and Public Health Management (Theory) 3 Credits

Unit 1: Introduction
Sources of Environmental hazards,
,

Unit 2: Climate Change
Green house gases and global warming, Acid rain, Ozone layer destruction, Effect of climate change on public health

Unit 3: Pollution
Air, water, noise pollution: sources, effects and control,

Unit 4: Waste Management Technologies
Sources of waste, types and characteristics, Solid waste disposal, Bio medical waste handling and disposal, e-waste management,
3R principle of waste management

Unit 5: Diseases
Causes, symptoms and control of tuberculosis, Cholera, Minamata disease,
Causes, symptoms and control of mosquito borne diseases–Malaria and Dengue
Control of Mosquitoes

Reference Books:

Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi,1999.
JosephFLouvarandBDianeLouverHealthandEnvironmentalRiskAnalysisfundamentalswithapplications,Prentice Hall,NewJersey1997.
Kasperson,J.X. and Kasperson,R.E.and Kasperson,R.E., Global Environmental Risks,V.N.UniversityPress,NewYork,2003.
Kofi Asante Duah "Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.
Kolluru Rao, Bartell Steven, PitbladoR and Stricoff" Risk Assessment and Management Handbook", McGraw Hill Inc.,NewYork,1996. 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, SribhumiPublicationCo. Kolkata Medical Entomology, Hati A.K AlliedBook Agency,Kolkata

Zoology Multidisciplinary Paper-3

Semester-3

MD-3: Apiculture (Theory) 3 Credits

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), Bee hives-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), Pollenetc

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

Reference Books

Prost, P.J.(1962). Apiculture. Oxford and IBH, New Delhi.
Bisht D.S., Apiculture, ICAR Publication.
Singh S., Beekeeping in India, Indian council of Agricultural Research, New Delhi.