



# **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**

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## Introduction:

The syllabus for Zoology at undergraduate level using the NEP-2020 and formulation of a new student-centric “**Curriculum and Credit Framework 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 of Course (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 / NUMBER OF 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		24	9	9	8	8	2		124
	64									
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		32	9	9	8	8	2		164
	96									
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 four courses in Major in VIII semester  
Honours with Research students will opt any one core course from available four courses in Major in VIII semester



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### 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 )			
VIII (Without Research)	Bioinstrumentation and Research Methodology Environmental Chemistry and Toxicology Biodiversity and Conservation Biology Medical techniques		Ecology and conservation Biology	



# 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	Non chordate Diversity (Theory & Practical)	4 (T+P)	10	40 T:25 P:15	50	3	0	2
2	S/ZOO/102/MN-1	Non chordate (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
<b>Total in Semester-I</b>			<b>20</b>	<b>60</b>	<b>240</b>	<b>300</b>			

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
<b>Total in Semester-II</b>			<b>20</b>	<b>60</b>	<b>240</b>	<b>300</b>			

- 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 do not studied the subject in H.S. level).
- Skill Enhancement Course (SEC) for the students of Zoology Major.
- Summer Internship one of 4 credits is compulsory within 1<sup>st</sup> year for Certificate, within 2<sup>nd</sup> year for Diploma, within 3 year for degree and within 4<sup>th</sup> year for Degree with Honours.



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			

## 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	5 X 1 = 05
2	2	4	5	2 X 5 = 10
3	1	2	10	1 X 10 = 10

### For 40 Marks paper

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

**Programme Outcome of Zoology (PO)**

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



**Programme Specific Outcomes of Zoology (PSO)**

PSO	Description
<b>PSO. 1</b>	<p><b>The core courses include diversified fields of life sciences viz:</b></p> <ul style="list-style-type: none"> <li>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 .</li> <li>b) Concept of classifying these diversified groups of animals using taxonomical approaches. Evolutions of animals are studied by following evolutionary principles.</li> <li>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.</li> <li>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.</li> <li>e) Molecular biological parameters in the form of DNA, RNA and proteins and their similarities and uniqueness in all living organisms.</li> <li>f) Protective approaches of animals against infectious diseases termed as immunity are studied to develop global concept of immunity following immunological principles.</li> <li>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.</li> <li>h) Endocrine regulation and coordination of different physiological system are studied in an independent course in the form of endocrinology.</li> <li>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.</li> </ul>
<b>PSO. 2</b>	Applied zoology in the form of fish farming, poultry etc. are studied independently by including separate programme called department specific elective in broader perspective so that the learners become seriously devoted to the subject.
<b>PSO. 3</b>	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.
<b>PSO. 4</b>	Generic Elective courses have been incorporated as interdisciplinary to teach overall concept of the subject so that student from other department of study may choose the courses according to their interest.
<b>PSO. 5</b>	Students ripen their investigative proficiency so that they can open up the entrances of the future knowledge world.
<b>PSO. 6</b>	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.
<b>PSO. 7</b>	Students will be able to analyze and solve the problems related to animal sciences without relying on assumptions and guesses.
<b>PSO. 8</b>	Students will be able to make solutions of biological problems by experimentation and subsequent data processing by modern technologies and computer applications.



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



# Zoology Major-1

## Semester-I

### MJC-1: Non Chordate Diversity (Theory)

**3 Credits****Course Outcomes:**

1. This course includes the concept of living organisms which are grouped into six kingdoms and the idea behind such grouping. Knowing the differences among other five non-animal to that of animal kingdom enables to have a clear idea of animal characteristics.
2. To study animals in systematic pattern it needs to classify animal groups using taxonomical principles. Therefore Taxonomy is incorporated in the course.
3. The common structural pattern of all animals 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 Pseudocoelomates. Pseudocoelomates are triploblastic animals without true coelom and therefore the topic of development of coelome is also included. Thus non-chordate I contents teaches on the basics of animal characters and their organized study methods.
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 course also includes classificatory schemes, structural and functional aspects of the non-chordate groups from annelids to echinoderms.

**Unit 1: Introduction**

Coelom: Types, Evolution and significance

**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 up to phylum (Levine et. al., 1981)

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

**Unit 4: Porifera**

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

**Unit 5: Cnidaria**

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

**Unit 6: Platyhelminthes**

General characteristics and classification up to classes

**Unit 7: Nematoda**

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

**Unit 8: Annelida**

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

**Unit 9: Arthropoda**

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

**Unit 12: Echinodermata**

1. General characteristics and Classification up to 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, 6<sup>th</sup> Edition**

**Reference Books**

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

**MJC-1: Non chordate Diversity (Practical)****1 Credit****Course Outcomes:**

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

**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 mouthparts 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:****Full marks: 15**

- |   |           |
|---|-----------|
| 1. Identification with reasons (any three):         | 3x2= 6    |
| 2. Dissection (any one) (From Item no. 3, 4 and 5 ) | 4 [2+1+1] |
| 3. Staining/ Mounting (any one) (From Item no. 6):  | 3 [1+1+1] |
| 4. Laboratory Note book                             | 2         |

**\*Note:**

Q1. For Item (1), Sc. name: 0.5 mark, Systematic Position 0.5 and Reasons: 1 mark  
 For Item (2) 1 mark 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, organisation, 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**

##### **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 up to order

##### **Unit 4: Pisces**

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

##### **Unit 5: Amphibia**

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

##### **Unit 6: Reptilia**

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

##### **Unit 7: Aves**

1. General characteristics and classification 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

##### **Unit 10: 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 Pub Co.  
 Futuyama, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.  
 Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.  
 Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.  
 Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.  
 Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.  
 Mandal FB (2013) Vertebrate Zoology, Oxford and IBH Co Pvt Ltd, New Delhi  
 Nelson, J.S., (2006): Fishes of the World, 4th Edn., Wiley.  
 Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Wiliam (Eds.) 7th Ed. Macmillan Press, London.  
 Pough H. Vertebrate life, VIII Edition, Pearson International.  
 Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.  
 Sinha, K. S., Adhikari, S., Ganguly, B. B. & Bharati Goswami, B. D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.  
 Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.  
 Kardong, K.V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education  
 Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies  
 Hilderbrand, M (1988). Analysis of Vertebrate Structure. 3<sup>rd</sup> Edition, John Wiley and Sons  
 Saxena, R.K. & Saxena, S.C. (2008): Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

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

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, Tylotriton, Chelone, Chamaeleon, Draco, Vipera, Naja, Alcedo, Psittacula, Pteropus, Funambulus,*
2. Identification of disarticulated skeleton of Pigeon and Guinea pig [ Skull, Vertebrae (Atlas, Axis), 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 X<sup>th</sup> Cranial nerves of carp
7. Submission of Laboratory Note Book

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

1. Identification with reasons (any three;)
2. Mounting and staining
3. Dissection
4. Submission of laboratory note book:

**Full marks: 15**

- 6 (2+2+2)\*  
 2  
 5 (3+1+1)\*  
 2

**Zoology Major-3****Semester-III****MJC-3: Ecology (Theory)****3 Credits****Course outcomes:**

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

**Unit 1: Introduction to Ecology**

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, 3rd edition. Sinauer associates  
Chapman, R. L. and Reiss, M. J. (2000). Ecology - Principles & Application. Cambridge University Press  
Dash, M. C., (2001). Fundamental of Ecology. 2nd Ed. Tata McGraw-Hill Company  
Kormondy, E. J. (2002). Concepts of Ecology. 4th Indian Reprint, Pearson Education  
Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.  
Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole  
Robert Leo Smith Ecology and field biology Harper and Row publisher  
Russel, P.J., Wolfe, L. S., Hertz, P.E. Starr, C. & McMillan, B. (2008). Ecology  
Stilling P (2009) Ecology: Theories & Application 4th Edition, Prentice Hall of India.  
Van Dyke, F. (2008). Conservation Biology: Foundations, Concepts, Application. 2nd Ed. Springer Science and Business Media.



**MJC -3: Ecology (Practical)****1 Credit****Course outcomes:**

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

**Practical**

1. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community
2. Field base experiment for data collection/Insect pitfall trapping/ Light trapping/ Quadrat 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<sub>2</sub>
4. Report on a visit to National Park/Zoological Park/Wild life 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 <sub>2</sub> or free CO <sub>2</sub> 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  
Darrell S Vodopich, (2009), 'Ecology Lab Manual', McGraw-Hill Higher Education  
Sinha, J.K. , Chatterjee, A.K. and P. Chattopadhyay (2015) Advanced Practical Zoology, Books & Allied (P) Ltd



**Zoology Major-4****Semester-III****MJC-4 : Fundamentals of Biochemistry (Theory)****3 Credits****Course Outcomes:**

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

**Unit 1: 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 terpenoids.
2. Lipid metabolism:  $\beta$ -oxidation of fatty acids; Fatty acid biosynthesis

**Unit 3: Proteins**

1. Amino acids : Structure, Classification, General and Electrochemical properties of  $\alpha$ -amino acids; Physiological importance of essential and non-essential amino acids
2. Proteins: Bonds stabilizing protein structure; Levels of organization
3. Protein metabolism: Transamination, Deamination, Urea cycle, Fate of 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
3. Basic concept of nucleotide metabolism

**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, Factors affecting rate of enzyme- catalyzed reactions
3. Enzyme inhibition; Lineweaver-Burk plot , Allosteric enzymes and their kinetics; Strategy of enzyme action
4. Catalytic and Regulatory (Basic concept with one example each)

**Reference Books:**

- Berg, J.M., Tymoczko, J.L. and Stryer, L.(2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York
- Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
- Das, D. (2000). Biochemistry. Central Book Agency, Kolkata
- Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
- Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
- Rodwell (2018) Harpers Illustrated Biochemistry, 31<sup>st</sup> Edn, Mc Graw Hill
- Sathyanarayana U. and Chakrapani, (2002). Biochemistry –Books & Allied (P) Ltd, Kolkata
- Voet. D & Voet. J.G, Pratt CW (2012). Principles of Biochemistry –4th edition, 2004, John Wiley & Sons, Inc.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.
- Zubay G.L, (1998). Biochemistry –4th edition, Mc Graw-Hill

**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 well as estimation of enzymatic activity.

**Practicals**

1. Qualitative tests of functional groups in carbohydrates (Benedict), proteins (Biuret) and lipids (Saponification).
2. Quantitative estimation of protein by Lowry Method
3. Study the enzymatic activity of amylase 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:****Full marks: 15**

- |   |   |
|---|---|
| 1. Qualitative Test (any one; 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: 1 mark and result 2 marks
- Q2. Principle 1 marks and result 3 marks
- Q3. Principle 1 mark and result 3 marks

**Suggested Reading:**

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

**Zoology Major-5****Semester-IV****MJC – 5: Cell Biology (Theory)****3 Credits****Course outcomes:**

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

**Unit 1: 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, Facilitated transport
3. Cell junctions: Tight junctions, Gap junctions, Desmosomes

**Unit 3: Cytoplasmic organelles**

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

**Unit 4: Nucleus**

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

**Unit 5: Cell Division**

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

**Unit 6: Cell cycle and cancer**

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

**Unit 7: Cell Signalling**

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

**Reference Books**

- Albert Bruce, Bray Dennis, Levis, Julian ,Raff Martin, Roberts Keith and Watson James (2008).Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London.
- Cooper, G.M. and Hausman, R.E. (2009). The Cell: A MolecularApproach.5thEdition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.Hardin, J. Bertoni, G and Klein smith, J. L. (2012). Becker's World of the Cell. 8th Edn, Pearson Benjamin Cummings, San Francisco.
- Harvey, L. (2004). Molecular Cell Biology. 5th Edn. W.H. Freeman
- Karp, G. (2008). Cell and Molecular biology: Concepts and Application. 5th Edn, John Wiley.
- Lodish, Berk, Matsudaira, Kaiser, Bretscher, Ploegh, Amon, and Martin (2016) Molecular Cell Biology. 8th Edn. W.H. Freeman



Plopper, G, D. Sharp, Siroski, E (2015) Lewin's Cell 3rd Edition—Johns & Bartlett Publishers Pollard and Earnshaw (2007). Cell Biology. 2nd. Edn Saunders.

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

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

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

### MJC-5: Cell Biology (Practical)

**1 Credit**

#### Course outcomes:

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

In addition to the above 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

**Full marks: 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 note book:  | 2        |
| 5. Viva   | 2        |

#### \*Note:

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

#### Suggested Reading

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

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

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

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



## **Zoology Major-6**

### **Semester-IV**

#### **MJC - 6 : Animal Physiology: Life Sustaining System**

**3 Credits****Course outcomes:**

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

**Unit 1: Physiology of Digestion**

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

**Unit 2: Physiology of Respiration**

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

**Unit 3: Physiology of Circulation**

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

**Unit 4: Physiology of Heart**

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

**Unit 5: Thermoregulation & Osmoregulation**

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

**Unit 6: Renal Physiology**

1. Structure of Kidney and its functional unit
2. Mechanism of urine formation
3. Regulation of acid-base balance

**Reference Books**

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

**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 (any one; From Item no. 1 or 2):      | 7 [5+2] *            |
| 2. Experiment (any one; 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 5 marks and for result 2 marks

Q2. For item no. (3 and 4): preparation 2 marks and 1 mark each for drawing and labelling. For item no. (5), 3 marks for procedure and 1 marks for result



## **Zoology Major-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 post embryonic development.

**Unit 1: Introduction**

1. Basic concepts: Phases of Development
2. Cell cell interaction, Differentiation and growth
3. Differential gene expression

**Unit 2: 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 up to gastrulation
5. Embryonic induction and organizers

**Unit 3: Late Embryonic Development**

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

**Unit 4: Post Embryonic Development**

1. Development of brain and Eye in Vertebrate
2. Brief idea of regeneration

**Unit 5: Implications of Developmental Biology**

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

**Reference Books**

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

**MJC-7 : Developmental Biology (Practical)****1 Credit****Course outcomes:**

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

**Practicals**

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

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

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

**\*Note:**

Q1. Identification: 1 mark and reasons: 2 marks



**Zoology Major-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, Lamarkism, Darwinism and Neo Darwinism, Geological time scale, Fossil records of hominids, Neutral theory of molecular evolution, Molecular clock, Population genetics: Hardy-Weinberg Law, Genetic Drift mechanism e.t.c

**Unit 1**

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

**Unit 2**

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

**Unit 3**

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

**Unit 4**

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

**Unit 5**

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

**Unit 6**

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

**Unit 7**

Phylogenetic trees, Convergent, Divergent and Parallel evolution.

**Reference Books:**

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

**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****Full marks: 15**

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

**\*Note:**

Q1. Identification: 1 mark and reasons: 1 marks

**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 Minor -1**

### **Semester- I**

#### **MN-1 : Non Chordate (Theory)**

**3 Credits****Unit 1: 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 up to phylum (Levine et. al., 1981)

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

**Unit 4: Porifera**

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

**Unit 5: Cnidaria**

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

**Unit 6: Platyhelminthes**

General characteristics and classification up to classes

**Unit 7: Nematoda**

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

**Unit 8: Annelida**

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

**Unit 9: Arthropoda**

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

**Unit 12: Echinodermata**

1. General characteristics and Classification up to 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, 6<sup>th</sup> Edition**

**Reference Books**

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

**MN-1: Non Chordate (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 mouthparts 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:**

	<b>Full marks: 15</b>
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 (any one) (From Item no. 6):	4 (2+1+1)
4. Laboratory Note book	2

**\*Note:**

Q1. For Item (1), Sc.name: 0.5 mark, Systematic Position 0.5 and Reasons: 1 mark.  
 For Item (2) 1 mark 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 Minor-2

### Semester-II

#### **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 up to order

**Unit 4: Pisces**

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

**Unit 5: Amphibia**

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

**Unit 6: Reptilia**

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

**Unit 7: Aves**

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

**Unit 8: Mammals**

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

##### GROUP B

**Unit 9: Integumentary System**

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

**Unit 10:**

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 Mammalia to be followed from Young (1981), for Pisces to be followed from Romer (1959), for Amphibia to be followed from Nobel (1924).

**Reference Books**

Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.  
 Futuyama, D. (1997). Evolutionary Biology. 3rd Ed. Sinauer Associates, INC.  
 Hall B.K. and Hallgrímsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.  
 Jordan, E.L. & Verma, P.S. (2003). Chordate Zoology. S. Chand & Company Ltd. New Delhi.  
 Kardong, K. V. (2002). Vertebrates: Comparative anatomy, function evolution. Tata McGraw Hill.  
 Kent, G. C. & Carr, R. K. (2001). Comparative anatomy of the Vertebrates. 9th Ed. McGraw Hill.  
 Mandal FB (2013) Vertebrate Zoology, Oxford and IBH Co Pvt Ltd, New Delhi  
 Nelson, J.S., (2006): Fishes of the World, 4th Edn., Wiley.  
 Parker, T. J. & Haswell, W. (1972). Text Book of Zoology, Volume II: Marshall and Wiliam (Eds.) 7th Ed. Macmillan Press, London.  
 Pough H. Vertebrate life, VIII Edition, Pearson International.  
 Romer, A. S. & Parsons, T. S. (1986). The vertebrate body. 6th Ed. Saunders College Publishing.  
 Sinha, K. S., Adhikari, S., Ganguly, B.B. & Bharati Goswami, B.D. (2001). Biology of Animals. Vol. II. New Central Book Agency (p) Ltd.  
 Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.  
 Kardong, K. V. (2005) Vertebrates' Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education  
 Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw-Hill Companies  
 Hilderbrand, M (1988). Analysis of Vertebrate Structure. 3rd Edition, John Wiley and Sons  
 Saxena, R.K. & Saxena, S.C. (2008): Comparative Anatomy of Vertebrates, Viva Books Pvt. Ltd.

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

1. Identification of following specimen  
*Branchiostoma, Petromyzon, Scoliodon, Torpedo, Heteropneustes, Exocoetus, Hippocampus, Necturus, Bufo, Tylotriton, Chelone, Chamaeleon, Draco, Vipera, Naja, Alcedo, Psittacula. Pteropus, Funambulus,*
2. Identification of disarticulated skeleton of Pigeon and Guinea pig [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 X<sup>th</sup> cranial nerves of carp
7. Submission of Laboratory Note Book

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

1. Identification with reasons (any three);
2. Mounting and staining
3. Dissection
4. Submission of laboratory note book:

**Full marks: 15**

6 (2+2+2)\*  
 2  
 5 (3+1+1)\*  
 2

## Zoology Minor-3

### Semester-III

#### **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: Cardiovascular system**

Structure of Heart, Cardiac cycle, Composition of blood, Blood Coagulation

**Unit 4: Excretion**

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

**Unit 5: Nerve and muscle**

Structure of 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**

$\beta$  oxidation of palmitic acid

**Unit 9: Protein metabolism**

Transamination, Deamination

**Unit 10: 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 Textbook of Medical Biochemistry. 8th Edn. Jaypee Pub., N.Delhi
3. Das, D. (200). Biochemistry. Central Book Agency, Kolkata
4. Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
5. Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). Harper'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, New Delhi
9. Sherwood, L. (2013). Human Physiology from cells to systems. 8th Edn., Brooks & Cole
10. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley & Sons, Inc.

**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. 1 or 5)  | 03 |
| 4. Identification of histological section [ (From Item No. 2 and 3) any three (3 x 2)= 06 |    |
| 5. Laboratory Note Book   | 02 |

**Note:**

- Q1. Principle 1 marks and result 3 marks  
Q2. Principle 1 marks and result 2 marks  
Q3. ½ marks for identification and 1½ mark for reasons each

**Suggested Readings:**

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



## Zoology Minor-4

### Semester-IV

#### **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

**Unit1: Introduction to Genetics**

Principles of Inheritance.

**Unit2: Extension of Mendelian Genetics**

Chromosome theory of inheritance, Incomplete dominance and co dominance, 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.

**Unit4: Mutations**

Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations

**Unit5: Sex Determination**

Chromosomal mechanisms in *Drosophila*.

**Unit6: 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

**Unit 7: 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 Analysis and Principles. 4<sup>th</sup> Edn. McGraw Hill.
3. Chattopadhyay, S. (2012). Life: Evolution, Adaptation, Ethology. 3rd Edn. Books and Allied, Kolkata.
4. Futuyma, D. J. (1997). Evolutionary Biology. Sinauer Associates.
5. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Ed. Wiley India.
6. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2010). Introduction to Genetic Analysis WH Freeman.
7. Hall, B. K. and Hallgrímsson, B. (2008). Evolution. IV Edition. Jones and Bartlett Publishers
8. Hyde, D. (2009). Introduction to Genetic Principle. McGraw Hill.
9. Kardong, K. (2004). An Introduction to Biological Evolution. McGraw Hill.
10. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings.
11. Pierce, B.A. (2013). Genetics Essentials: Concepts and Connections. 2<sup>nd</sup> Edn. Freeman W.H.
12. Ridley, M. (2004). Evolution. III Edition. Blackwell Publishing
13. Russel, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.
14. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.

**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 Practical**

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, Klinefelter's, Turner, Cri-du-Chat syndrome) from photograph
3. Identification of homology and analogy from suitable specimens/pictures,
4. Linkage maps based on Drosophila crosses
5. Identification of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test
6. Submission of Laboratory Note Book

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

- |   |            |
|---|------------|
| 1. Identification with reasons (any four from item 1, 2 and 3) [at least one from each group] | = 08 (4×2) |
| 2. One question (From Item 4 or 5)  | = 05       |
| 3. Laboratory Note Book   | = 02       |
| Note  |            |
| Q 1 .½ mark for identification and 1½ mark for reasons  |            |



## Zoology Skill Enhancement Courses (SEC-1)

### Semester-I

#### SEC-1: Sericulture (Theory)

**3 Credits****Unit 1: 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**

Life cycle of *Bombyx mori*

Structure of silk gland and secretion of silk

**Unit 3: Rearing of Silkworms**

Selection of mulberry variety and establishment of mulberry garden]

Rearing house and rearing appliances.

Disinfectants: Formalin, bleaching powder,

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: Uzi fly, dermestid beetles and vertebrates

Pathogenesis of silk worm 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 Disease of Silkworm,1956, Ptd.By Director of Ptg.,Stn. & Pub.Govt. Press, Bangalore

Appropriate Sericultural Techniques; Ed.M.S. Jolly, Director ,CSR & TI,Mysore.

Handbook of Silkworm Rearing: Agriculture and TechnicalManual-1,FuziPub. Co. Ltd., Tokyo, Japan1972.

Manual of Silkworm Egg Production; M.N. Narasimhanna, CSB, Bangalore1988.

Silkworm Rearing;Wupang—Chunand Chen Da-Chung, Pub.ByFAO,Rome1988.

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

Improved Method of Rearing Young age silk worm; S. Krishnaswamy, reprinted CSB,Bangalore,1986

**Zoology Skill Enhancement Courses (SEC-2)****Semester-II****SEC -2 Aquarium 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

**Zoology Skill Enhancement Courses (SEC-3)****Semester-III****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.

**Unit 1: Agricultural Entomology**

Pest-definition and types (major and minor pests with example).

Study of lifecycle, nature of damage and control of paddy Pest (*Scirpophaga incertulus*), stored house pest (*Sitophilus oryzae*); Insect Pest control: Chemical, Mechanical, Cultural and Biological control measures; Integrated Pest Management (IPM).

**Unit 2: 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

**Unit 3: 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 by products with economic importance; Diseases of poultry and their control measures.

**Unit 5: Entrepreneurship 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, New Delhi.
- 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. 3rd Ed. John Wiley & Sons, Inc.
- Pedigo, L. P. & Rice E. M. (2009). Entomology and Pest Management. 6th Ed. 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 Silkworm**

Lifecycle of *Bombyx mori*  
Structure of silk gland, Composition of Silk 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,  
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, Rome 1976  
Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore  
Silkworm Rearing and Disease of Silkworm, 1956, Ptd. By Director of Ptg., Stn. & Pub. Govt. Press, Bangalore  
Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.  
Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi Pub. Co. Ltd., Tokyo, Japan 1972.  
Manual of Silkworm Egg Production; M.N. Narasimhanna, CSB, Bangalore 1988.  
Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988.  
A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989.  
Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986

**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, Biomedical waste handling and disposal, e-waste management, 3 R 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.

Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997.

Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V. N. University Press, New York, 2003.

Kofi Asante Duah " Risk Assessment in Environmental management", John Wiley and sons, Singapore, 1998.

Kolluru Rao, Bartell Steven, Pitblado Rand Stricoff "Risk Assessment and Management Handbook", McGrawHill Inc., New York, 1996.

U K Imms, A.D. (1977). A General Text Book of Entomology. Chapman & Hall, UK

Mathews, G. (2011). Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases. Wiley-Blackwell

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



## 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), Beehives - Newton and Langstroth

Bee Pasturage

Selection of Bee Species for Apiculture

Bee Keeping Equipment

Methods of Extraction of Honey (Indigenous and Modern)

##### Unit 3: Diseases and Enemies

Bee Diseases and Enemies

Control and Preventive measures

##### Unit 4: Economic Importance

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

##### Unit 5: Entrepreneurship in Apiculture

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

##### Reference Books

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

Bisht D.S., Apiculture, ICAR Publication.

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