

MANGALORE UNIVERSITY

B.Sc. DEGREE COURSE

CHOICE BASED CREDIT SYSTEM

COURSE PATTERN AND SCHEME OF EXAMINATION

CORE SUBJECT: ZOOLOGY

Core/Elective	Paper Code	Title of the Paper	Instruction Hours	Duration of the Examination (Hrs)	Max. Marks			Credits
					Exam	IA	Total	
I Semester B.Sc.								
Group I Core Subject	Theory BSCZOC-131	Animal Diversity-I (Non chordata)	4	3	80	20	100	2
	Practical BSCZOP-132	Animal Diversity-I (Non chordata)	3	3	40	10	50	1
Group II Elective (Supportive to the discipline of study)	Theory BSCZOCE-133	Parasitology and Vector Biology	2	2	40	10	50	1*
Total number of Credits for Core Subject in I Semester: 03								
II Semester B.Sc.								
Group I Core Subject	Theory BSCZOC-181	Animal Diversity - II (Chordata)	4	3	80	20	100	2
	Practical BSCZOP-182	Animal Diversity - II (Chordata)	3	3	40	10	50	1
Group II Elective (Providing an expanded scope)	Theory BSCZOCE-183	Instrumentation and Techniques in Biology	2	2	40	10	50	1*
Total number of Credits for Core Subject in II Semester: 03								
III Semester B.Sc.								
Group I Core Subject	Theory BSCZOC-231	Physiology, Biochemistry and Immunology	4	3	80	20	100	2
	Practical BSCZOP-232	Physiology, Biochemistry and Immunology	3	3	40	10	50	1
Group II Elective (Nurturing students proficiency/skill)	Theory BSCZOCE-233	Aquarium Fish Keeping	2	2	40	10	50	1*
Total number of Credits for Core Subject in III Semester: 03								

IV Semester B.Sc.								
Group I Core Subject	Theory BSCZOC- 281	Histology, Animal Behavior, Applied Zoology	4	3	80	20	100	2
	Practical BSCZOP- 282	Histology, Animal Behavior, Applied Zoology	3	3	40	10	50	1
Group II Elective (Enabling an exposure to some other discipline/ domain)	Theory BSCZOCE- 283	Vermitechnology	2	2	40	10	50	1*
Total number of Credits for Core Subject in IV Semester: 03								
V Semester B.Sc.								
Group I Core Subject	Theory BSCZOC- 331	Cell Biology and Biotechnology	3	3	80	20	100	2
	Theory BSCZOC- 332	Genetics, Biostatistics, Evolution and Paleontology	3	3	80	20	100	2
	Practical BSCZOP- 333	Cell Biology, Biotechnology, Genetics, Biostatistics, Evolution and Paleontology	4	4	80	20	100	2
Total number of Credits for Core Subject in V Semester: 06								
VI Semester B.Sc.								
Group I Core Subject	Theory BSCZOC- 381	Reproductive Biology and Developmental Biology	3	3	80	20	100	2
	Theory BSCZOC- 382	Environmental Biology, Toxicology and Wildlife Biology	3	3	80	20	100	2
	Practical BSCZOP- 383	Reproductive Biology and Developmental Biology, Project work - Environmental Biology, Toxicology and Wildlife Biology	4	4	80	20	100	2
Total number of Credits for Core Subject in VI Semester: 06								
Total number of Credits for Core Subject in I-VI Semesters: 24								

* Credits for Elective Papers will be considered for the entire B.Sc. Programme

MANGALORE UNIVERSITY
B.Sc. DEGREE COURSE
CHOICE BASED CREDIT SYSTEM
SYLLABUS
CORE SUBJECT: ZOOLOGY

Program Outcome: B.Sc.

- Ability to communicate effectively in both oral and written contexts in the form of technical papers, project reports, design documents and seminar presentations.
- Demonstrate knowledge and understanding of essential facts, concepts, principles and theories relating to subject areas.
- Apply ethical principles and commit to professional ethics, responsibilities and norms.
- Develop critical thinking with scientific temper.
- Enhance the research culture in the field of life sciences and uphold the scientific integrity and objectivity.
- Understand the biodiversity and to apply the knowledge to conserve endangered species.
- Acquire basic skills in the observation and study of nature, biological techniques, experimental skills and scientific investigation.

Program Specific Outcome: ZOOLOGY

Upon successful completion of three year B.Sc. Programme in Zoology the students will be able to:

- Understand and analyze relationships between structure and function at different levels of biological organization for the various groups of animals.
- Develop deeper understanding of key concepts of zoology such as ethology, physiology, embryology, etc. at organism, cellular, and molecular level.
- Describe the role of taxonomy and systematics in animal studies and gain in-depth knowledge of animals.
- Understand the unity of life with the rich diversity of organisms and their ecological and evolutionary significance.
- Correlate between the various animal habitats and their behavior.
- Generate awareness about the conservation of the biosphere.
- Explore various applied fields of Zoology such as apiculture, fisheries, poultry, vermiculture, dairy farming, etc. and gain in-depth knowledge which enables self-employment.
- Acquire basic skills in the observation and study of nature, biological techniques, experimental skills and scientific investigation.
- Organize and deliver the acquired knowledge through effective written, verbal, graphical/virtual communications and interact productively with people from diverse backgrounds.
- Use concepts, tools and techniques related to chemistry and botany to acquire knowledge and its application in zoology.

Course Objectives:

1. The course is intended to make a student conscious about the beauty of the animal kingdom, the role played by the animals in the ecosystem, and importance of animals in this planet.
2. The course helps a student to utilize various techniques and methods in the study of

- animals.
3. The course aims to instill a deep knowledge in the student about the body functions and behaviour of animals.
 4. The course intends to instill the basic knowledge and skills about the applied aspects such as animal husbandry, fisheries, etc.
 5. The course helps a student to gain in depth knowledge of cellular and molecular aspects of life.
 6. The course provides the knowledge of the history of mankind, the origin and specialization of life forms on earth and an insight of working principle of the process of evolution of life.
 7. The course is intended to make a student knowledgeable about the means of his/her own development from the earliest stage and also knowledgeable about his/her surroundings and its importance in his/her own life.

I SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-131: ANIMAL DIVERSITY-I (NON-CHORDATA)
(Hours of instruction: 4 hours/week. Total: 48 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Understand the basic principles of animal taxonomy.
2. Appreciate the vast biodiversity of local and global level and get an insight about the need for conservation.
3. Identify the invertebrates and classify them up to the class level with the basis of systematics.
4. Create the awareness of the economic importance and significance of invertebrates.

Unit - I: Introduction, Biodiversity, Protozoa

1.1 Introduction

3 Hrs

Principles of animal classification - Binomial nomenclature, Linnaean hierarchy; Criteria for animal classification - body layers, coelom, body symmetry, metamerism, cephalisation; Definition of species; Phylogeny; Classification of Animal Kingdom up to phylum.

1.2 Biodiversity

3 Hrs

Levels of biodiversity - species, genetic and ecosystem level diversity; Concept of Biodiversity hotspots; Biodiversity hotspots of India with emphasis on Western Ghats & Himalaya hotspots.

1.3 Phylum: Protozoa

6 Hrs

General characters of the phylum and classification up to classes with distinctive characters and suitable examples; Structure and life history of malarial parasite (*Plasmodium vivax*) and human parasitic protozoan (*Entamoeba histolytica*).

Unit - II: Porifera, Cnidaria, Ctenophora

2.1 Phylum: Porifera

6 Hrs

General characters of the phylum and classification up to classes with distinctive characters and suitable examples; Histology, spicules and canal system in sponges; Systematic position of Porifera.

2.2 Phylum: Cnidaria and Ctenophora

6 Hrs

General characters of the phylum and classification up to classes with distinctive characters and suitable examples; Polymorphism in hydrozoa with reference to *Physalia* and *Halistemma*; Coral reefs – Fringing, Barrier, Atoll; Structure of Corallite; Factors affecting coral reef formation; Theories of Coral reef formation; Metagenesis in *Obelia*.

2.2.1 Distinctive characters of Ctenophora, Externals of *Pleurobrachia*.

Unit - III: Platyhelminthes, Nemathelminthes and Annelida

3.1 Phylum: Platyhelminthes 4 Hrs

General characters of the phylum and classification up to classes with distinctive characters and suitable examples; Structure and life history of liver fluke and tapeworm; Parasitic adaptations of liver fluke and tape worm.

3.2 Phylum: Nemathelminthes 3 Hrs

General characters of the phylum with suitable examples; External characters, life cycle and pathogenicity of *Ascaris* and *Wuchereria* (Filarial worm), preventive measures.

3.3 Phylum: Annelida 5 Hrs

General characters of the phylum and classification up to classes, distinctive characters giving suitable examples; Tubicolous adaptations in *Sabella* and *Chaetopterus*; External features, circulatory and excretory systems and life history of earthworm.

Unit - IV: Arthropoda, Onychophora, Mollusca and Echinodermata

4.1 Phylum: Arthropoda and Onychophora 5 Hrs

General characters of the phylum and classification up to classes with distinctive characters and suitable examples; Externals of marine prawn (*Penaeus*) with detailed account of appendages; Metamorphosis in insects – Definition, Types with examples – ametabola, hemimetabola and holometabola; Externals of *Peripatus* and affinities of Onychophora.

4.2 Phylum: Mollusca 3 Hrs

General characters of the phylum and classification up to classes, with distinctive characters and suitable examples; External features of *Unio* and *Pila*.

4.3 Phylum: Echinodermata 4 Hrs

General characters of the phylum and classification up to classes with distinctive characters and suitable examples; External features and water-vascular system of *Asterias*; Larval forms of Echinodermata – Bipinnaria, Echinopluteus, Auricularia and Doliolaria.

Note:

1. Local examples with common and scientific names are to be given more emphasis for all the groups.
2. While selecting the examples, only such of the salient features of the examples have to be mentioned which are necessary to explain the general characters of the phylum/class.

I SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-132: ANIMAL DIVERSITY-I (NON-CHORDATA)
(3 Hours/week)

Course Outcome: Upon completion of the course the students will be able to:

1. Identify different invertebrates and assign them to their respective taxonomical group based on the characters studied.
2. Identify different organ systems of invertebrates through dissection of their body.

A. Museum specimens and slides.

Commonly available specimens cited in the list of examples are to be selected for practicals.

B. Dissections (Demonstration only)

1. Prawn: Nervous system
2. Earthworm: Nervous system
3. Leech: a) Digestive system
b) Reproductive system
4. Cockroach: a) Digestive system
b) Nervous system
c) Male and female reproductive systems
5. Observations of hay infusion culture to study living protozoans like *Euglena*, *Paramecium*, *Vorticella*, *Amoeba* etc.

C. Mounting and Whole mount preparations

- i) Demonstration of mounting of the following:
 - a. Prawn: Appendages
 - b. Leech: i) Salivary gland cells
ii) Jaw
 - c. Cockroach: Salivary glands, Mouth parts
 - d. Earthworm: Ovary, Body setae
- ii) Whole mount preparation: Cnidarian colonies - *Obelia*, *Sertularia*, *Pennaria*, *Tubularia* (any two); Crustacean larvae – Nauplius, Zoea, Mysis (any two) - Processing and mounting.

LIST OF MUSEUM SPECIMENS AND SLIDES

1. Slides of *Elphidium*, *Euglena*, *Plasmodium*, *Paramecium*, and *Vorticella*
2. Specimens of *Euplectella*, *Sycon*, slides of sponge spicules.
3. *Obelia*, *Physalia*, *Aurelia*, *Sea anemone*, *Fungia*
4. Planaria, Liver fluke, Tapeworm, *Ascaris* (Male and Female), *Wuchereria bancrofti*.
5. *Nereis*, *Arenicola*, *Chaetopterus*, *Pheretima*
6. *Carcinus* (male or female crab), *Peripatus*, *Lepas*, *Scolopendra*, *Limulus* and *Palamnaeus* (Scorpion)
7. *Chiton*, *Dentalium*, *Xancus*, *Aplysia*, *Pila*, *Unio/Lamellidens*, *Nautilus*, *Octopus*.
8. *Asterias* (Star fish), *Ophiothrix* (Brittle star), *Echinus* (Sea-urchin), *Cucumaria* (Sea-Cucumber), *Antedon* (Sea-lily), Bipirinarina larva, Pluteus larva.

I SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-132: ANIMAL DIVERSITY- I (NON-CHORDATA)

SCHEME OF EXAMINATION

I. Dissection - Identify, draw labeled diagram and comment on the flagged systems A and B . (Identification of the system - ½ Mark; Identification of the flagged part - ½ Mark; Labelled diagram of the entire system - 2 Marks; Description of flagged part - 1 Mark)	08
II. Mounting – Identify and comment on C . [Any one item from C (i)] (Identification -1 Mark; Diagram -1 Mark; Minimum two unique characters -1 Mark)	03
III. Mounting – Make a stained, temporary mounting of the given material D . [Any one item from C (ii)] (Stained preparation-2 Marks; Procedure-1 Mark)	03
IV. Identify, classify, draw labeled diagram and comment on E, F, G, and H . (1 slide, 3 specimens). (Identification - ½ Mark; Classification -½ Mark; Labelled diagram -1 Mark; Four Comments - 2 Marks)	4x4=16
V. Class records	10

Note: Questions must be framed as per the scheme provided.

REFERENCES:

1. Adam Sedgwick - A Students Text Book of Zoology, Low Price Publications, Delhi, Vol. I, II & Vol. III, 1990.
2. Agarwal V.K. – Zoology for Degree Students: Non-Chordata, S. Chand & Company, 2017.
3. Barnes R. D. - Invertebrate Zoology, Saunders College, Philadelphia, 1980.
4. Dhami & Dhami - Invertebrate Zoology, R. Chand & Co., 2009.
5. Ekambaranatha Ayyar - A Manual of Zoology Vol. I, Part I & II, S. Vishwanathan Pvt. Ltd., 1982.
6. Hyman, L. H. - The Invertebrates - Vols. I to IV, Mc. Graw Hill, 1940.
7. Jordan & Verma - Invertebrate Zoology, S. Chand & Company, New Delhi, 2013.
8. Kotpal - Modern Text Book of Invertebrates, Rastogi Publications, Meerut, 2017.
9. Kotpal - Protozoa to Echinodermata (Phylum Series), Rastogi Publications, Meerut, 2017.
10. M. Prakash & C. K. Arora - Laboratory Animals, Anmol Publications, New Delhi, 1998.
11. P.S. Verma - A Manual of Practical Zoology – Invertebrates, S. Chand & Co., 2013.
12. S.S. Lal- A Text book of Practical Zoology – Invertebrates, Rastogi Publications, 2016.
13. T. Jeffery Parker, William A. Haswell. A Text Book of Zoology, Low Price Publications, Delhi, Vol. I & II, 1990.

II SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-181: ANIMAL DIVERSITY-II (CHORDATA)
(Hours of instruction: 4 hours/week. Total: 48 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Describe the diversity in form, structure and habits of protochordates and vertebrates.
2. Explain general characteristics and classification of different classes of vertebrates.
3. Identify and distinguish between poisonous and non-poisonous snakes by observing characteristic features.
4. Understand the basic anatomy of vertebrate body.

Unit - I: Hemichordata, Chordata, and Cyclostomata

1.1 Hemichordata

2 Hrs

General characters of the phylum and external features of *Balanoglossus*; Tornaria larva; Systematic position of Hemichordata.

1.2 Chordata

2 Hrs

General characters of Chordata and outline classification up to subphyla.

1.2.1 Protochordata

2 Hrs

Characters of Urochordata and Cephalochordata with examples; External features of *Herdmania* and *Branchiostoma*.

1.3. Vertebrata

2 Hrs

General characters of Vertebrata; Outline classification up to classes.

1.4 Cyclostomata

4 Hrs

General characters; External features and differences between Lamprey (*Petromyzon*) and Hag fish (*Myxine*), Structure of Ammocoetes larva and its metamorphosis.

Unit - II: Pisces and Amphibia

2.1. Pisces - General characteristics of fishes and aquatic adaptations of fishes. 1 Hr

2.2 Chondrichthyes and Osteichthyes

3 Hrs

General characters of Chondrichthyes with examples; General characters of Osteichthyes with examples.

2.3 Amphibia

3 Hrs

General characters and classification up to orders; Distinguishing features of Anura, Apoda and Urodela with suitable examples.

2.3.1 Endoskeleton of Frog

5 Hrs

Skull, lower jaw, hyoid apparatus, vertebral column, pectoral and pelvic girdles, limb skeleton.

Unit - III: Reptilia and Aves

3.1 Reptilia

6 Hrs

General characters and classification up to orders (living orders only) with suitable examples; Temporal fossae and arcades in reptiles; Indian snakes – Examples of poisonous and Non-poisonous snakes; Distinguishing poisonous from non-poisonous snakes; Poison apparatus and its working mechanism; Snake venom and anti venom.

3.2 Aves

6 Hrs

General characters and classification; Distinctive features of Archaeornithes and Neornithes with reference to Palaeognathae, Impennae and Neognathae giving suitable examples; Flight Adaptations in birds.

Unit - IV: Mammalia and Exoskeleton

4.1 Classification and distinctive features

4 Hrs

General characters and classification up to subclasses; Distinctive features of Prototheria, Metatheria and Eutheria with important examples; Affinities of Prototheria.

4.2. Important characters of following Eutherian orders with examples.

5 Hrs

Primates, Chiroptera, Cetacea, Perissodactyla, Artiodactyla, Carnivora and Rodentia.

4.3. Organ systems

2 Hrs

Detailed study of digestive system and reproductive system of Rat.

4.4 Exoskeletal structures in Vertebrates

1 Hr

Fish Scales, Feathers, Horns/Antlers, Hooves, Hairs – Structure & types.

Note:

1. Local examples with common and scientific names are to be given more emphasis for all the groups.
2. While selecting the examples, only such of the salient features of the examples have to be mentioned which are necessary to explain the general characters of the phylum/class.

II SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-182: ANIMAL DIVERSITY-II (CHORDATA)
(3 Hours/week)

Course Outcome: Upon completion of the course the students will be able to:

1. Identify different chordates and assign them to their respective taxonomical group based on the characters studied.
2. Identify different organ systems of vertebrates in dissected animal.
3. Identify various exoskeletal and endoskeletal structures of vertebrates.

A. Museum specimens and slides

Commonly available specimens cited in the list of examples are to be selected for practicals.

B. Dissections (Demonstration only)

1. Mouse
 - a) Digestive system
 - b) Male and Female Urinogenital systemsOR
2. Fish - Afferent branchial system, Cranial nerves V, VII, X.

C. Mounting

Fish scales (Placoid, Cycloid and Ctenoid)

D. Study of Exoskeletal structures: Bird feathers (Down feather, Contour feather); Horns (Cattle, Sheep); Hooves (Cattle, Horse/ Donkey)

E. Study of Endoskeletal structures: Skull (Amphibian, Reptilian, Avian, Mammalian); Vertebrae, Girdles and limb skeleton of Frog.

LIST OF MUSEUM SPECIMENS AND SLIDES

1. *Balanoglossus*, *Herdmania*, *Amphioxus*. Tornaria larva (all).
2. *Petromyzon*, *Myxine*, *Ammocoetes* larva (all).
3. *Narcine* (Electric ray), *Pristis* (Saw fish), *Trygon* (Sting ray), *Scoliodon* (Shark) (Any two).
4. *Anguilla*, *Hippocampus*, *Anabas testudineus*, *Catla catla*, *Clarius batrachus*, *Gambusia affinis* (Any two).
5. *Ichthyophis* (Caecilian), *Bufo melanostictus* (Common Toad), *Rana hexadactyla* (Indian Pond Frog), *Rana cyanophlyctis* (Skipper Frog), *Hoplobatrachus tigerinus* (Indian Bull Frog), *Rhacophorus malabaricus* (Malabar Gliding Frog), *Ambystoma*, *Salamander*, Axolotl larva (1 limbless; 1 tailed; others -2).
6. *Hemidactylus frenatus* (Southern House Gecko), *Calotes versicolor* (Common garden Lizard), *Varanus benghalensis* (Common Indian Monitor), *Draco dussumieri* (Draco), *Calotes rouxi* (Forest Calotes), *Chameleon zeylancius* (Indian Chameleon), *Crocodylus porosus* (Mugger) - (any two).
7. *Ptyas mucosus* (Common rat snake), *Bungarus fasciatus* (Banded Krait), *Bungarus caeruleus* (Common Indian Krait), *Naja naja* (Indian Cobra), *Python molurus* (Indian Python), *Trimeresurus malabaricus* (Pit Viper), *Eryx conicus* (Russell's Earth Boa), *Daboia russelii* (Russell's Viper) - (any two).
8. *Geochelone elegans* (Starred Tortoise), *Geochelone travancorica* (Travancore Tortoise), *Chelone mydas* (any one).

9. *Pycnonotus jocosus* (Red whiskered Bulbul), *Dicrurus adsimilis* (Black Drongo or King crow), *Oriolus xanthonus* (Black-hooded Oriole), *Sturnus pagodarum* (Blackheaded or Brahminy Myna), *Psittacula cyanocephala* (Blossom headed Parakeet), *Haliastur indus* (Brahminy Kite), *Centropus sinensis* (Crow Pheasant), *Ardea cinerea* (Grey Heron), *Corvus splendens* (House Crow), *Passer domesticus* (House Sparrow), *Tyto alba* (Indian Barn Owl), *Ploceus philippinus* (Indian Baya), *Oriolus oriolus* (Indian Golden Oriole), *Pavo cristatus* (Indian Peafowl), *Acridotheres tristis* (Common Myna), *Ardeola grayii* (Indian Pond Heron or Paddybird), *Nectarinia asiatica* (Indian Purple Sunbird), *Copsychus saularis* (Magpie Robin), *Amauronis phoenicurus* (Indian Whitebreasted Waterhen), *Dinopium benghalense* (Lesser Golden backed Woodpecker), *Egretta garzetta* (Little Egret) - (any three).
10. Echidna, *Bandicota indica* (Bandicoot Rat), *Lepus nigricollis* (Black naped hare), *Macaca radiata* (Bonnet Macaque), *Presbytis entellus* (Common Langur), *Herpestus edwardsi* (Common Mongoose), *Paradoxurus hermaphrodites* (Common Palm Civet), *Petaurista philippensis* (Common giant flying squirrel), *Funambulus palmarum* (Three striped palm squirrel), *Rousettus leshenulti* (Fulvous fruit bat), *Mus musculus* (House Mouse), *Rattus rattus* (House Rat), *Pteropus giganteus* (Indian Flying Fox) - (any three).

- Note:** 1. Local examples with common and scientific names are to be given more emphasis for all the groups.
 2. Only such of the salient features of the examples have to be mentioned which are necessary to explain the general characters of the phylum/class.
 3. In the event of non availability of specimens, related internet downloaded photos/movies can be shown.

**II SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
 BSCZOP-182: ANIMAL DIVERSITY-II (CHORDATA)**

SCHEME OF EXAMINATION

- I. Dissection - Identify, draw labeled diagram and comment on the flagged systems **A** and **B**.
 (Identification of the system - ½ Mark; Identification of the flagged part - ½ Mark; Labelled diagram of the entire system - 2 Marks; Description of flagged part - 1 Mark) 08
- II. Mounting – Make a stained, temporary mounting of the given material **C** (Fish Scale) 02
 (Stained preparation-2 Marks)
- III. Identify, classify, draw labeled diagram and comment on **D**, **E**, and **F**. 3x4=12
 (Identification-½ Mark; Classification-½ Mark; Labelled diagram-1 Mark; Four Comments-1 Mark)
- IV. Exoskeleton – Identify and comment on **G**. 02
 (Identification-1 Mark; Minimum two unique features-1 Mark)
- V. Endoskeleton – Identify and comment on the material **H** and **I** (One Skull/Girdle/limb Skeleton; One vertebra)
 (Skull/Girdle/Limb Skeleton: Identification-1 Mark; Minimum six unique features-3 Marks)
 (Vertebra: Identification - ½ Mark; Minimum 3 unique features - 1½ Marks) 4+2=06
- VI. Class records 10

TOTAL = 40

Note: Questions must be framed as per the scheme provided.
Question no. 1 Dissection shall be done by concerned staff beforehand.

REFERENCES:

1. Adam Sedgwick - A Students Text Book of Zoology, Low Price Publications, Delhi, Vol. I, II & Vol.III, 1990.
2. Colbert E.H. - Evolution of the Vertebrates, Wiley Student Edition, 2011.
3. Dhama & Dhama - Chordate Zoology, R. Chand & Co., 2014.
4. Ekambaranatha Ayyar - A Manual of Zoology Vol. II, S. Vishwanathan Pvt. Ltd., 1982.
5. Jordan & Verma - Chordate Zoology, S. Chand & Company, New Delhi, 2013.
6. K. Prabhakar Achar & K. Geetha Nayak - Birds of Dakshina Kannada, Bhuvanendra Nature Club - India, 2000.
7. Kotpal R.L. - Modern Text Book of Zoology – Vertebrates, Rastogi Publications, 2016.
8. M. Prakash & C. K. Arora - Laboratory Animals, Anmol Publicating, Ansari Road, New Delhi, 1998.
9. Prasad S.N. - Modern Text Book of Zoology – Vertebrates, New Age International Ltd., 2013.
10. R.T. Orr – Vertebrate Biology, Saunders College Publishing, 1982.
11. S. A. Hussain & K.P. Achar - Biodiversity of the Western Ghats Complex of Karnataka, Biodiversity Initiative Trust, Mangalore, 1999.
12. T. Jeffery Parker, William A. Haswell - A Text Book of Zoology, Low Price Publications, Delhi, Vol. I & II, 1990.
13. Verma P.S. - A Manual of Practical Zoology (Vertebrates), S. Chand & Co., 2013.

III SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-231: PHYSIOLOGY, BIOCHEMISTRY AND IMMUNOLOGY
(Hours of instruction: 4 hours/week. Total: 48 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Understand the functions of various systems, and apply the knowledge to lead a healthy life.
2. Understand the importance of Bio molecules, and familiar with various biochemical pathways.
3. Explain the role of immune system in maintaining health, immunological response and the way it is triggered and regulated.

Unit - I: Physiology

1.1 Introduction

1 Hr

Definition; Branches and scope of physiology.

1.2 Osmoregulation

3 Hrs

Definition; Types of solutions-hypotonic, isotonic and hypertonic; Osmoconformers and Osmoregulators; Osmoregulation in shark, marine and fresh water teleosts, terrestrial mammals (Kangaroo rat and camel).

1.3 Thermoregulation

2 Hrs

Ectotherms, Endotherms, and Heterotherms; Temperature regulation in Poikilotherms and Homeotherms; Aestivation and hibernation.

1.4 Digestion

3 Hrs

Gross anatomy of human digestive system; Mechanical and enzymatic digestion; Digestion and absorption of proteins, carbohydrates and lipids; Hormonal control of digestion and absorption; Ruminant digestion.

1.5 Respiration

3 Hrs

External and internal respiration; Respiratory pigments - Haemoglobin, haemocyanin and haemoerythrin; Physiology of respiration - exchange of gases - transport of oxygen - oxygen dissociation curves - Bohr effect - transport of carbon dioxide - chloride shift; Respiratory quotient.

Unit - II: Physiology (Contd....)

2.1. Circulation

4 Hrs

Types of circulation; Structure, functions and regulation of human heart; Origin and conduction of heart beat; Blood pressure - hypertension and hypotension; Composition of human blood – Plasma, Erythrocytes, leucocytes and platelets; Neurogenic and Myogenic hearts.

2.2 Nitrogen Excretion

4 Hrs

Nitrogen excretion in aquatic and terrestrial animals – Ammonotelism, Ureotelism and Uricotelism with examples; Ornithine cycle in humans; Physiology of urine formation in humans – ultrafiltration, tubular reabsorption and tubular secretion.

2.3 Muscle Contraction

4 Hrs

Principal types of muscles; Ultrastructure of striated muscles; Contractile proteins - myosin, actin, tropomyosin, troponin and actinin; Mechanism of muscle contraction and relaxation - the

sliding filament theory; Structure of neuromuscular junction; Properties of Muscle - Muscle fatigue, muscle twitch, muscle tetanus, rigor mortis.

Unit - III: Physiology (Contd....)

3.1 Nerve Coordination

4 Hrs

Types of nervous systems; Gross anatomy of human brain; Structure and types of neurons; Nature and conduction of nerve impulse; Types of synapses and synaptic transmission; Neuro-transmitters in vertebrates.

3.2 Sense Organs

4 Hrs

Classification of sense organs – Photo-, chemo- and thermoreceptors, statoacoustic organs; Structure of mammalian ear and mechanism of hearing; Structure of mammalian eye and mechanism of image formation; Organs of Jacobson; Echolocation.

3.3 Endocrine System

4 Hrs

Human endocrine glands – Functions of Pituitary, thyroid, parathyroid, pancreas, adrenals, and pineal glands; Hormonal disorders in humans; Neurosecretory releasing factors; Hypothalamus - stimulating and inhibitory effects.

Unit - IV: Biochemistry and Immunology

4.1 Biochemistry

4.1.1 Proteins – Definition; A brief account of amino acids; Classification of proteins, examples and biological importance of proteins. 1 Hr

4.1.2 a. Carbohydrates – Definition, classification, examples; Biological importance.

b. Lipids - Definition, classification, examples; Biological importance. 1 Hr

4.1.3 Enzymes – Definition, types; Classification of enzymes (IUB system); Mechanism of enzyme action – Lock and key model and Induced fit model; Factors affecting enzyme action; Mechanism of enzyme inhibition; Clinical importance of enzymes. 2 Hr

4.1.4 Vitamins - Fat soluble vitamins (A, D, E and K), water soluble vitamins (B-complex and vitamin C), Functions and deficiency symptoms. 2 Hrs

4.2 Immunology

6 Hrs

Immune System - innate and acquired; Cells of immune system; Organs of immune system - Primary lymphoid organs (Bone Marrow, Bursa of Fabricius, Thymus), Secondary lymphoid organs (Lymphoid follicles, lymph nodes, Peyer's patches); Antigens and Antigenicity; Immunoglobulins - structure and functions of IgG; Primary and secondary immune responses; Immunization; Autoimmune diseases – Definition, examples – Type I Diabetes and Rheumatoid Arthritis.

III SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-232: PHYSIOLOGY, BIOCHEMISTRY AND IMMUNOLOGY
(3 Hours/week)

Course Outcome: Upon completion of the course the students will be able to:

1. Analyze human blood samples through laboratory techniques to find out health and disease conditions.
2. Analyse various food samples to determine the nature of nutrients present.
3. Analyse human urine samples through laboratory techniques to find out health and disease conditions.

MAJOR EXPERIMENTS:

A. Physiology:

1. Total erythrocyte count in human blood sample.
2. Total leucocyte count in human blood sample.
3. Salivary amylase activity test of human saliva.
4. Osmotic haemolysis in animal cells.

B. Biochemistry:

1. Qualitative tests:
 - a. Carbohydrates: Molisch's Test, Benedict's test for glucose, Iodine test for starch.
 - b. Proteins: Biuret test, Xanthoprotic test, Ninhydrin test.
 - c. Nitrogenous excretory wastes:
 - i. Ammonia - Nessler's reagent test.
 - ii. Urea – Sodium hypobromite test.
 - iii. Uric acid - Folin's uric acid reagent test.
 - d. Abnormal constituents of Human urine:
 - i. Sugar (glucose) – Benedict's test.
 - ii. Albumen – Heller's Nitric acid ring test.
 - iii. Ketone – Rothera's test.

C. Immunology:

1. Preparation of stained blood smear and identification of different types of blood cells – RBCs, Neutrophils, Lymphocytes, Eosinophils, Monocytes, and Basophils.
2. Identification of organs of immune system – Bone marrow, Thymus, Lymph nodes, Spleen, Peyer's patches, Tonsils – Specimens/slides/charts/models.

***Note:** (Students have to identify the presence of the organic compound in the sample provided, giving the principle of reaction).

MINOR EXPERIMENTS:

1. Preparation of haematin crystals from human blood.
2. Determination of bleeding time of human blood.
3. Determination of clotting time of human blood.
4. Estimation of hemoglobin in human blood (Sahli's method).
5. Detection of lipids – Greasy spot test.

III SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-232: PHYSIOLOGY, BIOCHEMISTRY AND IMMUNOLOGY

SCHEME OF EXAMINATION

I.	Physiology experiment (by lots). (Conducting the test - 4 Marks; Principle/Procedure/observation/calculation/Inference - 4 Marks; Result - 2 Marks)	10
II.	Biochemistry experiment (by lots). Conduct suitable qualitative tests for the detection of Organic compounds/ Nitrogenous wastes/abnormal constituents of urine in the sample provided and report (Name of the test - 1 Mark; Principle - 2 Marks; Conducting the test - 3 Marks; Procedure/observation/inference (in tabular form) -3 Marks; Result -1 Mark)	10
III.	Immunology: Identify and comment on the Cell A and Organ B (Common for all). (Cell A: Identification - ½ Mark, Diagram – 1 Mark, Comments – 1 Mark. Organ B: Identification - ½ Mark, Comments – 2 Marks)	05
IV.	Minor experiment (any one) - Common for all. (Experiment - 4 Marks; Report-1 Mark)	05
V.	Class record	10
		TOTAL = 40

Note: Questions must be framed as per the scheme provided.

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IV SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-281: HISTOLOGY, ANIMAL BEHAVIOUR, APPLIED ZOOLOGY
(Hours of instruction: 4 hours/week. Total: 48 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Explain the gross anatomical structure of different organ systems and histological details of different organs in mammals in general and in humans in specific.
2. Apply skill-based knowledge of histological techniques.
3. Gain fundamental knowledge in the concepts of animal behavior which enable the student to conceptualize learning behaviour, communication, migration and biological rhythms in animals.
4. Identify various methodologies and perspectives of applied branches of zoology for the possibilities of self-employment.

Unit - I: Histology

12 Hrs

Importance of the study; Study of histological structure of following mammalian organs.

a) Tongue (b) Salivary glands (c) Stomach (d) Intestine (e) Ovary (f) Testis (g) Liver (h) Pancreas (i) Thyroid (j) Kidney (k) Adrenal (l) Pituitary

Unit - II: Animal Behaviour

2.1 Introduction, Types of Animal Behaviour

2 Hrs

Innate behaviour - taxes, reflexes, instincts and motivation;

Learnt behaviour - habituation, imprinting, conditioned reflexes and insight learning;

Biological clock - circadian rhythms.

2.2 Social Organisation in Animals

2 Hrs

Social behaviour – Definition; Social behaviour in Honey bees, termites, monkey troops; Methods of their communication.

2.3 Animal Migration

3 Hrs

Introduction; Advantages of migration; Migration in fishes - anadromous, catadromous; Migration in birds - types of migration, patterns of migration, orientation and navigation, preparation for migration; Methods of studying bird migration (suitable examples are to be cited)

2.4 Courtship and Nesting Behaviour

3 Hrs

Introduction; Courtship behaviour in Peacock, Baya Weaver Bird, River Tern, and Sarus Crane; Types of nests in birds; Nesting behaviour in Baya Weaver Bird, Hornbill, Tailor Bird, and Lapwing; Nesting behaviour in paper wasp and potter wasp.

2.5 Parental Care

2 Hrs

Parental care in fishes (*Hippocampus*, *Ophiocephalus*, *Tilapia* species, *Arius* species) and amphibians (*Rhacophorus*, salamander, *Hyla*, *Pipa* and *Ichthyophis*).

Unit - III: Applied Zoology

3.1 Dairy

4 Hrs

Introduction; Breeds of dairy animals; Cattle: Milch breeds - Red Sindhi, Gir; Draught breeds - Amrithmahal, Hallikar; Dual breeds - Krishna valley, Ongole; Exotic breeds – HF, Jersey, Red

Dane; Buffalo breeds - Nagpuri, Surti; Goat breeds - Jamunapuri, Malabari; Feeding and raising of dairy animals; Milk - composition and uses; Milk products - Butter, Ghee, Cheese and Paneer - uses; Utility of cattle in agriculture and transport, biogas, fertilizer and gelatin production.

3.2 Poultry

4 Hrs

Introduction; Poultry breeds - layers, broilers and dual purpose breeds with any two examples each; Desi breeds of poultry - Aseel, Chittagong, Kadaknath, Giriraja; Housing management of poultry – intensive and semi-intensive methods; Poultry diseases – Ranikhet, Fowl pox, Tick fever (Spirochaetosis), Fowl cholera, Tape worm and Round worm diseases; Prevention and control of poultry diseases.

3.3 Vermitechnology

4 Hrs

Life history of earthworms; Ecological classification of earth worms (Epigeic, anesic, endogeic); Introduction to vermiculture; Methods of vermiculture – bin and pit methods; Preparation of vermicompost from any organic waste material (weeds, waste, domestic wastes, paper wastes etc.); Vermiwash; Uses of vermicompost and vermiwash in agriculture.

Unit - IV: Applied Zoology (Contd...)

4.1 Aquaculture

4 Hrs

Definition, importance of aquaculture; Techniques of culturing fresh water, brackish water and marine fishes; Culture of ornamental fishes; Induced breeding and seed fish production; Transport of seed fish and brooding fish; Fish diseases and their control – White spot disease, Gyrodactylosis, Bacterial gill rot, Epizootic ulcerative syndrome, nutritional disease-pin heads.

4.2 Apiculture

4 Hrs

Introduction; Bee species used for apiculture; Flora for Apiculture; Methods of bee keeping – Traditional method, Modern method – Langstroth model; Predators of honey bees; Extraction of honey; Nutritive value and uses of honey; Bee wax and its uses; Diseases of honey bees and control - Nosemosis, American Foulbrood, Chalk Brood, Thai Sac Brood.

4.3 Pearl Culture

2 Hrs

Species of Pearl Oysters and their occurrence; Formation of natural pearl; Pearl producing sites in India; Steps involved in pearl culture – Oyster collection, Rearing, Insertion of nucleus, Post-operational care, Harvesting; Importance of Pearls.

4.4 Lac Culture

2 Hrs

Lac insect – *Kerria lacca* – Structure and life history; Host plants; Cultivation of Lac; Economic importance of Lac.

IV SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-282: HISTOLOGY, ANIMAL BEHAVIOUR, APPLIED ZOOLOGY
(3 Hours/Week)

Course Outcome: Upon completion of the course the students will be able to:

1. Prepare slides and identify various mammalian tissues.
2. Identify various birds' nests, castes of honey bees and parental care behaviour.
3. Identify various useful animal products.
4. Carryout systematic field work to gain knowledge about animal behaviour and various applied aspects of animal life.

1. Observation of mammalian histology slides of the following organs: Stomach, Small intestine, Liver, Pancreas, Kidney, Ovary, testis, Thyroid and Adrenal.

2. Preparation of permanent slides of mammalian Stomach, Liver, Pancreas, Small intestine, Kidney, Testis, Ovary, Thyroid and Adrenal of Rat. (Any two slides prepared by the students have to be submitted at the time of examination).

3. Animal behaviour:

- a. Social behaviour in honey bees – Castes – Queen, Drone, Worker.
- b. Study of bird's nests – Any four different types of nests.
- c. Study of Parental care – *Hippocampus*, *Ichthyophis*.

3. a. Milk products – Curd, Butter, Ghee, Cheese, Paneer.
- b. Fish products – Fish oil, Fish meal, Fish manure.
- c. Honey and Beewax.
- d. Poultry – Egg, Meat.
- e. Pearl and Lac.

2. Field oriented practicals

- i. Study of nesting and roosting places in birds, study of various types of bird nests (as per the availability).
- ii. Field visit to study animal behaviour in natural habitat – Identification of castes/ Study of bee colonies, bee hives/ant colonies, ant nests/ termites and their mounds/ nesting behavior in solitary and social wasps/monkey troops etc.
- iii. Preparation of vermicompost using different raw materials (such as weeds, paper waste, domestic waste, sugar cane etc.)
- iv. Visit to honey bee rearing centers.
- v. Visit to fish/shrimp breeding centers.
- vi. Visit to dairy.
- vii. Visit to poultry farm.

Note: The field studies should be based on the above mentioned topics which shall be allotted at the beginning of semester. Each student shall prepare separate field report which is to be certified by staff in-charge and HOD. It should be submitted during practical examination which shall be evaluated by both internal and external examiners. Field work must be supported by proper documents and photographs of the field visit by individual students.

IV SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-282: HISTOLOGY, ANIMAL BEHAVIOUR, APPLIED ZOOLOGY

SCHEME OF EXAMINATION

I. Histology - Stain, mount, and identify the paraffin section provided. (Slide preparation - 5 Marks; Identification -1 Mark)	06
II. Histology – Identify, draw labelled diagram and comment on permanent slides A and B . (Identification -1 Mark; Labelled diagram -1 Mark; Comments - 2 Marks)	2x4 = 08
III. Animal behaviour: Identify and comment on C and D . (Identification - ½ Mark; Comments - 1½ Marks)	2x2 = 04
IV. Applied Zoology: Identify and comment on E , F , and G . (Identification - ½ Mark; Comments - 1½ Marks)	2x3 = 06
V. Field Report* (Introduction -1 Mark; Details of field visited - 1 Mark; Observations including photographs - 3 Marks; References -1 Mark)	06
VI. Class Record + Slides	8+2 = 10
	TOTAL = 40

*The Hand written field report (not exceeding 10 A4 size sheets) should include introduction, details of fields visited, detailed account of observations made, original photographs and references.

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V SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-331: CELL BIOLOGY AND BIOTECHNOLOGY
(Hours of instruction: 3 hours/week. Total: 40 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Understand the structure of cells and cell organelles in relation to the functional aspects and understanding of the working principles and applications of microscopes.
2. Understand the structure and functions of chromosomes; the process of cell division and its significance.
3. Gain fundamental knowledge of protein synthesis.
4. Understand the basic aspects of cancer biology.
5. Understand the applications of Biotechnology and be familiar with the tools and techniques of Biotechnology.

Unit - I: Cell Biology

1.1 Introduction

1 Hr

History of cell biology; Subdivisions of cell biology; Scope of cell biology.

1.2 Chromosomes

4 Hrs

Morphology of chromosomes - Structure - centromere, telomere; Heterochromatin and Euchromatin; Types of chromosomes, chromosome number, genome; Ultra structure of chromosomes - Folded fiber model, Nucleosome model, Giant chromosome - Polytene and Lamp brush chromosomes; Supernumerary chromosomes.

1.3 Nucleic Acids

5 Hrs

Introduction - Identification of genetic material - Griffith's experiment, experiments of Avery, MacLeod and McCarty, Hershey-Chase experiment; Chemistry of nucleic acids - structure of DNA - Watson and Crick DNA model; Mechanism of DNA replication - Meselson and Stahl's experiment; Forms of DNA (Non-coding, A, B, Z). DNA repair - Excision repair, photoreactivation and recombinational repairs; Types of RNA; Transcription and RNA processing (Intron splicing and post transcriptional modifications); A brief account on Ribozymes.

Unit - II: Cell Biology (Contd....)

2.1 Plasma membrane and cell junctions

2 Hrs

Fluid mosaic model of plasma membrane; Cell receptors - functions; Types of cell junctions; Cell adhesion; Extracellular matrix.

2.2 Cytoskeleton and cell motility

2 Hrs

Microtubules; Microfilaments; Intermediate filaments - organisation and functions.

2.3. Cell differentiation

2 Hrs

General characteristics, Nucleocytoplasmic interactions (Experiments with *Acetabularia*)

2.4 Cancer and Carcinogenic Agents

4 Hrs

Concept of cancer; Types of cancer; Characteristics of cancer cells; Oncogenes; Immune system and cancer; Carcinogenic agents - physical, chemical and biological; Strategies of

cancer therapy - Immunotherapy, Radiotherapy, Chemotherapy; Role of telomere in cell ageing and cancer; A brief account on apoptosis.

Unit - III: Cell Biology (Contd...)

3.1 Genetic Code and Protein Biosynthesis

3 Hrs

Definition; Properties of genetic code; Wobble hypothesis; Components of protein biosynthesis; Mechanism of protein biosynthesis.

3.2 Mitosis

3 Hrs

Cell cycle - Phases of cell cycle – interphase – prophase - centriole cycle - mitotic apparatus - metaphase, anaphase and telophase; Cytokinesis; Differences between mitosis in animal and plant cells; significance of mitosis; Mitotic inhibitors - examples and applications.

3.3 Meiosis

4 Hrs

Phases of meiotic cycle - I meiotic division - Synaptonemal complex and recombination; Mechanism of crossing over; cytological basis of crossing over (Stern's experiment); Significance of crossing over; Interkinesis; Second meiotic division; Significance of meiosis; Differences between mitosis and meiosis.

Unit - IV: Biotechnology

4.1 Introduction to Genetic Engineering

4 Hrs

Introduction; Restriction endonucleases (I, II and III) - use of linkers and adaptors; Cloning vehicles - plasmids, episomes, transposons, animal viruses, shuttle vectors; Gene libraries - genomic library - cDNA library; Introducing Cloned Genes into the Host Cells - Transformation, Transduction, Particle Gun, Electroporation, Liposome Mediated Cultivation.

4.2 Techniques in Biotechnology

3 Hrs

PCR technique, Southern, Northern and Western blotting technique; DNA finger printing - principle, method and applications; DNA sequencing - Maxam and Gilbert's method, Sangar and Cohlson's Method; Proteomics and genomics; Protein engineering; FISH, RAPD, RFLP - Definition and applications.

4.3 Applications of Biotechnology

3 Hrs

Introduction; Microbes in pollution control; Biotechnology in bioremediation; Biotechnology in disease prevention and diagnosis, Pharmaceuticals, Vaccines; Transgenic animals; Stem cells in transgenesis; Gene therapy.

V SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-333: CELL BIOLOGY AND BIOTECHNOLOGY
(2 Hours/week)

Course Outcome: Upon completion of the course the students will be able to:

1. Use different cytological techniques in the study of cell biology.

1. Study of fixatives and stains:
Formaldehyde (4 to 10%), Alcohol (70% to 100%), Carnoy's solution, Borax carmine (alcoholic), Eosin (alcoholic), Iron Haematoxylin, Acetocarmine, Acetoorcein, Schiff's reagent (Feulgen method), Mordant (4% Iron alum), Giemsa's stain.
(Note: Preparation procedure is to be included in the practical records).
2. Observation of permanent slides of onion root tip to study all stages of mitosis.
3. Observation of permanent slides of grasshopper testis to study various stages of meiosis.
4. Study of permanent slide of salivary gland chromosomes of *Drosophila/Chironomous* larva.
5. Squash preparation of onion root tip to demonstrate stages of mitosis.
6. Squash preparation of grasshopper testis to demonstrate stages of meiosis.
7. Squash preparation of salivary gland chromosomes of *Drosophila/ Chironomous* larva.
8. Extraction of DNA from coconut endosperm/chicken liver.
9. Study of different forms of DNA (A, B and Z) and types of RNA (t, r, m): Models or Photos.

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V SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-332: GENETICS, BIostatISTICS, EVOLUTION AND
PALAEONTOLOGY

(Hours of instruction: 3 hours/week. Total: 40 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Appreciate the contribution of great scientists; distinguish Classical Genetics and Molecular Genetics.
2. Describe the concepts of heredity, chromosomal aberrations, gene regulation and genetic diseases, its inheritance and importance of genetic counseling.
3. Critically analyze, think logically and reason, through solving genetic problems.
4. Able to manage the statistical data in biological studies.
5. Understand the concept of evolution through Lamarckism, Darwinism and Neo-Darwinism.
6. Understand the Geological time scale, fossils and their significance.

Unit - I: Genetics

1.1 Introduction and Laws of Inheritance

4 Hrs

Development of gene concept; Branches of genetics; Heredity and variation; Mendel's experiments - Mono and Dihybrid crosses, Test cross and Back cross; Mendel's laws of inheritance; Use of *Drosophila* in genetic studies; Dihybrid crosses in *Drosophila*.

1.2 Interaction of Genes (Modified genetic ratios)

3 Hrs

Incomplete dominance - 1:2:1 - Plumage pigmentation in fowl.

Supplementary factors - 9:3:3:1 - Comb pattern in fowls.

Dominant Epistasis - 12:3:1 - Plumage colour in Leghorn and Wyandotte; Coat colour in dog.

Recessive Epistasis - 9:3:4 - Coat colour in Guinea pigs.

Complementary factors - 9:7 - Flower colour in sweet peas.

Lethal genes - Coat colour in mice.

1.3 Multiple Alleles, Polygenic inheritance and Pleiotropism

3 hrs

ABO blood groups in humans; Rh factor - Erythroblastosis fetalis; Blood typing and blood transfusion; Legal aspects of blood group genetics; Inheritance of coat color in rabbit; Isoalleles; Pseudoalleles and position effect; Multiple factors/polygenes; Polygenic inheritance in man - skin color and eye color; Pleiotropism (Cystic fibrosis in humans and vestigial wing in *Drosophila*); Cytoplasmic inheritance - Shell coiling in *Limnaea* (snails), kappa particles in *Paramecium*).

Unit - II: Genetics (Contd....)

2.1 Nature and Nurture

1 Hr.

Definition; Norm of reaction, Experiments on Himalayan Albino rabbit and Human twins; Phenocopy; Penetrance and expressivity with examples.

2.2 Linkage and gene mapping

3 Hrs

Linkage – Definition; Complete and partial linkage in *Drosophila*; Significance of linkage; Theories of linkage; Linkage maps - Construction of chromosome maps; Two point test cross, double cross-overs, three point test cross.

2.3 Sex-determination and Sex linked inheritance

3 Hrs

Types of Sex chromosomes; Chromosomal mechanism of sex determination (XX-XY, XX-XO, ZZ-ZW and ZZ-ZO types with specific examples); Sex linked inheritance in *Drosophila* (White eye); Haemophilia and colour blindness in man; Sex linkage in birds (barred plumage pattern in poultry); Sex limited (plumage pattern in Leghorn fowls) and sex influenced traits (pattern baldness in humans).

2.4 Gene, Gene Mutation and DNA repair

3 Hrs

Concept of gene – definition; Fine structure of gene - cistron, muton, recon, introns; Regulation of gene expression - Operon concept - Lac Operon; Mutation - Types, point mutation, frame shift mutation, inversion, insertions; Molecular basis of mutations. CIB technique.

Unit - III: Human Genetics and Biostatistics

3.1 Human Genetics

4 Hrs

Human karyotype; Ideogram; Pedigree analysis; Common human chromosomal syndromes - Klinefelter's and Turner's Syndromes, Down's syndrome; Inborn errors of metabolism – Albinism, Phenylketonuria, Alkaptonuria, Sickle cell anemia, Thalassemia, Huntington's chorea; Prenatal diagnosis - Amniocentesis, chorionic villus sampling; Genetic counseling; Human genome project.

3.2 Biostatistics

6 Hrs

Introduction to biostatistics - Basic concepts; Presentation of data - Tabulation, frequency distribution, graphical and diagrammatic representation; Analysis of data - mean, median and mode; Standard deviation, standard error of mean (SEM); Tests of significance - Student t -test, chi-square test. (Wherever necessary, appropriate problems should be worked out).

Unit - IV: Evolution and Palaeontology

4.1 Speciation and theories of Organic Evolution

4 Hrs

Lamarckism; Darwin-Wallace theory of Natural Selection; Synthetic theory of evolution - Neo-Darwinism; Hardy-Weinberg law of equilibrium; Factors influencing change in gene frequencies of a population - gene mutation, gene flow, genetic drift; Natural Selection – types - Stabilizing selection, Directional selection and Disruptive selection; Artificial selection with examples (insecticidal resistance in insects or industrial melanism); Isolation and Isolating mechanisms – i. Geographical isolation. ii. Reproductive isolation - Prezygotic/Premating isolation – Ecological, Seasonal, Ethological, Mechanical, Physiological and Gametic mortality; Post zygotic/Postmating isolation – Cytological, Zygotic mortality, Hybrid inviability, Hybrid sterility; Speciation - sympatric and allopatric speciation.

4.2 Evidences of Organic Evolution

2 Hrs

Evidences from comparative morphology and anatomy, comparative physiology and biochemistry, comparative embryology and palaeontology.

4.3 Palaeontology

2 Hrs

Brief account of geological time scale; Fossils and fossilization; Dinosaurs; Study of connecting links: *Peripatus* and *Archaeopteryx*.

4.4. Evolution of Horse and Man

2 Hrs

Origin and evolution of horse (*Eohippus*, *Meshippus*, *Merichyppus* and *Equus*) and man (*Australopithecus*, Java ape man, Neanderthal man and Cro-Magnon Man); Evolutionary trend of horse and man.

V SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-334: GENETICS, BIOSTATISTICS, EVOLUTION AND
PALAEONTOLOGY
(2 Hours/week)

Course Outcome: Upon completion of the course the students will be able to:

1. Collect and raise a population of *Drosophila* in the laboratory for genetics experiments.
 2. Work out genetics and biostatistics problems to understand the basic concepts.
 3. Understand various concepts of evolution by studying live and fossil models.
1. Experiments with *Drosophila*.
 - a. Preparation of *Drosophila* culture media.
 - b. Phenotypic characters and sexual dimorphism in *Drosophila*.
 - c. Life cycle of *Drosophila*.
 - d. Mutants of *Drosophila* (white eye, bar eye, sepia eye, vestigial wing, curly wing, ebony body and yellow body – any four).
 - e. Mounting of sex comb.
 - f. Mounting of genital plate.
 2. Display of Barr body in buccal smear.
 3. Blood typing for the detection of ABO blood group and Rh factor.
 4. Genetics/Evolution problems
 - a. Genetic problems: Monohybrid inheritance (1)
 - b. Genetic problems: Dihybrid inheritance (1)
 - c. Genetic problems: Multiple alleles - ABO blood group in humans (1).
 - d. Sex-linked inheritance in *Drosophila* (1)
 - e. Sex linked inheritance in humans (1)
 - f. Calculation of allele frequency - ABO blood group in humans.
 5. Biostatistics problems
 - a. Graphical/diagrammatic representation (2)
 - b. Mean, median, mode (2)
 - c. Chi-square test (1)
 - d. Student t- test (1)
 6. Study of human karyotype: normal male, normal female, Turner's syndrome, Klinefelter's syndrome, Down's syndrome.
 7. Evolution
 - a. Study of homologous organs - forelimbs of frog and bird; mouth parts of cockroach, mosquito and butterfly.
 - b. Study of analogous organs - wings of insect and bird.
 - c. Study of vestigial organs - appendix and third molar tooth in man.
 8. Palaeontology
 - a. Connecting links: *Peripatus* and *Archaeopteryx*.
 - b. Living fossil: *Nautilus*.
 - c. Models of Dinosaurs: (Tyrannosaurus, Brontosaurus, Stegosaurus and Triceratops).
 - d. Study of models of fossil man. (Any two available models).

V SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-333: CELL BIOLOGY AND BIOTECHNOLOGY,
GENETICS, BIOSTATISTICS, EVOLUTION AND PALEONTOLOGY

SCHEME OF EXAMINATION

I. Squash - Make a stained squash preparation of onion root tip or grass hopper testis. (Stained slide preparation with at least one dividing stage - 6 Marks; Report - 1 Mark; Labeled diagram – 1 Mark; Comment – 2 Marks)	10
II. Squash - Make a stained squash preparation of salivary gland chromosomes. (Dissecting the gland - 3 Marks; Salivary gland chromosomes slide preparation - 4 Marks; Comments – 3 Marks)	10
III. Identify and comment on the permanent slides A & B with labeled diagrams. (1- mitosis and 1- meiosis) (Identification - 1 Mark; Labeled diagram – 2 Marks; Comments - 2 Marks)	2 x 5 = 10
IV. Solve the genetics problem A and biostatistics problem B . (Working out the problem - 4 Marks; Result – 1 Mark)	2 x 5 = 10
V. Mounting:	
a. Make a temporary mounting of the sex comb on a clean slide. (Mounting of entire tarsus with sex comb on a glass slide with cover slip and focused under low power)	05
b. Identify the ABO and Rh blood group of the given blood sample and comment on the significance of blood grouping. (Identification of ABO and Rh group $\frac{1}{2} + \frac{1}{2} = 1$ Mark; Reasons $2+1 = 3$ Marks (student should write the antigen antibody reaction of the identified blood group; Significance - 1 Mark)	05
VI. Identify the <i>Drosophila</i> mutants C and D with reasons. (Identification - $\frac{1}{2}$ Mark; Chromosome number and site - $\frac{1}{2}$ Mark; Characters -2 Marks)	3 x 2 = 06
VII. Identify and comment on E (Specimen or model from Evolution or Palaeontology). (Identification - 1 Mark; Labeled diagram - 1 Mark; Comments - 2 Marks)	04
VIII. Class record	10+10 = 20
	TOTAL: 80

Note: Questions must be framed as per the scheme provided.

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14. Suzuki, Griffiths, Miller & Lewontin – An Introduction to Genetic Analysis, W.H. Freeman & Company, New York, 1986.
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VI SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-381: REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL
BIOLOGY

(Hours of instruction: 3 hours/week. Total: 40 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Understand the structure and functions of the reproductive systems.
2. Familiar with various stages involved in embryonic development of different organisms including man.
3. Understand the principles of IVF-ET and the importance of it.
4. Familiar with different techniques involved in embryonic studies.

Unit - I: Reproductive Biology

1.1 Reproductive system 2 Hrs

Male reproductive system: primary sex organs - male accessory ducts - copulatory organ - accessory glands; Female reproductive system - primary sex organs - female accessory organs - accessory glands - external genitalia; Secondary sexual characters in humans.

1.2 Gametogenesis 3 Hrs

Spermatogenesis - Formation of spermatids - Spermiogenesis - Structure of mature Spermatozoan; Oogenesis - Previtellogenesis and Vitellogenesis - Estrous cycle in non-primate mammals and menstrual cycle in humans; Comparison between spermatogenesis and Oogenesis.

1.3 Parthenogenesis 2 Hrs

Kinds of parthenogenesis - Natural – Arrhenotoky, Thelytoky - automixis and apomixes; Cyclical parthenogenesis in gall wasps and aphids; Larval parthenogenesis in liver flukes; Artificial parthenogenesis; Significance of parthenogenesis; Hermaphroditism.

1.4. Modern trends in Reproduction 3 Hrs

Manipulation of reproduction - Gene bank, Sperm bank, Superovulation, Cryopreservation; *In-vitro* fertilization (IVF) and embryo transfer (ET); Zygote intra fallopian transfer (ZIFT); Intra uterine transfer (IUT); Gamete intra fallopian transfer (GIFT); Intra cytoplasmic sperm injection (ICSI); Intra-uterine insemination(IUI); Artificial insemination (AI); Animal cloning; Cloning of Dolly; Applications of animal cloning.

Unit - II: Developmental Biology

2.1 Introduction 3 Hrs

Definition and scope; Basic concepts in developmental Biology; Theories of development - Preformation theory, Epigenetic theory, Baer's Law and Biogenetic law; Branches of embryology; Phases of ontogenetic development – Development and differentiation; Patterns of development - Oviparity, ovo-viviparity and viviparity with examples.

2.2 Type of Eggs and Sperms 1 Hr

Types of eggs based on amount and distribution of yolk with examples; Mosaic and regulative eggs; Cleidoic egg and its significance; Types of sperms with examples.

2.3 Fertilization 3 Hrs

Kinds of fertilization - external, internal, self and cross fertilization with examples; Mechanism of fertilization - approximation of gametes – chemotaxis - fertilizin and antifertilizin – capacitation - acrosome reaction and sperm penetration - activation of ovum - cortical reaction and fertilization membrane formation – Amphimixis; Monospermic & polyspermic fertilization; Significance of fertilization.

2.4 Cleavage 3 Hrs

Definition, Laws of cleavage; Types of cleavage - holoblastic and meroblastic; Patterns of cleavage – radial, biradial, spiral and bilateral cleavage with examples; Effects of yolk on cleavage; Types of blastula with examples.

Unit - III: Developmental Biology (Contd....)

3.1 Organizer Phenomenon 3 Hrs

Definition - The amphibian organizer; The organizer's role in development; Potencies of the dorsal lip of the blastopore of amphibian gastrula; Brachet's experiment; Experiment of Spemann and Mangold; Induction of Organizer; Chemical nature of organizer; Parts of organizer; Theories of organizer phenomenon.

3.2 Early Development of Frog 4 Hrs

Cleavage - Blastula - Fate maps of Blastula - Gastrulation - Mesogenesis - Notogenesis and Neurulation.

3.3 Early Development of Chick 3 Hrs

Structure of hen's egg - cleavage - blastula - gastrulation - origin and structure of primitive streak - structure of 18, 24 and 48 hours chick embryos.

Unit - IV: Developmental Biology (Contd...)

4.1 Extraembryonic Membranes of Chick 2 Hrs

Development, Structure and functions of Yolk-sac, Amnion, Chorion and Allantois.

4.2 Placenta 3 Hrs

Yolk sac placenta; Allantoic placenta; Structure and functions of placenta; Morphological and histological classification of placenta with examples.

4.3 Early Development of Human Foetus 3 Hrs

Structure of a mature sperm and Graafian follicle; Ovulation; Fertilization; Morula - blastocyst - implantation – gastrulation; Placenta - structure and functions; Twins and multiple births.

4.4 Role of Hormones in Development 2 Hrs

Gonadotropins and their functions; Hormones secreted by testis and ovaries and their functions; Hormones of placenta and their functions.

VI SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-383: REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL
BIOLOGY
(2 Hours/week)

Course Outcome: Upon completion of the course the students will be able to:

1. Understand basic concepts of embryology through the study of various embryological stages of different animals.

1. Study of different types of eggs and sperms:
Type of eggs: Insect, amphioxus, frog, chick and human (any 4)
Type of sperms: Frog, domestic fowl, rat, mouse and human (any 4)
2. Stages of development of frog: Study of cleavage stages, blastula, gastrula and neurula (sections) and various stages of tadpole.
3. Study of permanent slides of chick embryo: 18 hrs, 24 hrs, 36 hrs and 48 hrs (WM); T.S. of 18 hrs and 24 hrs chick embryo.
4. Study of permanent slides/charts of histological types of placenta (All five)
5. Study of charts or models of morphological types of placenta: Diffuse, cotyledonary, intermediate, zonary and discoidal placenta.
6. Whole mount preparation (Permanent)
 - a. Mosquito larvae.
 - b. Zoa, Nauplius, Mysis.

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14. Subramanian – Developmental Biology, MJP Publishers, 2013.
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VI SEMESTER B.Sc.: ZOOLOGY (THEORY)
BSCZOC-382: ENVIRONMENTAL BIOLOGY, TOXICOLOGY AND WILDLIFE
BIOLOGY

(Hours of instruction: 3 hours/week. Total: 40 Hrs)

Course Outcome: Upon completion of the course the students will be able to:

1. Understand the structural and functional components of ecosystems and the complex mechanisms involved in the functioning of ecosystems.
2. Understand the concept of environmental pollution, effects and means of prevention.
3. Understand the effects of pesticides and toxins on the humans, animals and environment.
4. Appreciate the fauna of the world, in general by studying the zoogeographic realms, of India in particular, by studying distribution of animals.
5. Understand various threats for wildlife, role of different agencies and wildlife acts and policies in preventing wildlife depletion.

Unit - I: Environmental Biology

1.1 Introduction

2 Hrs

Ecological spectrum; Subdivisions of ecology; Concept of habitat - Micro-habitat and Macro-habitat; Ecological Niche - Spatial, Trophic and Multidimensional.

1.2 Abiotic Factors

2 Hrs

Major abiotic factors - Light, Water, Temperature and Soil; Adaptation to extreme environment - Effect of light and temperature on animals - Cyclomorphosis.

1.3 Biotic Factors

3 Hrs

Mutualism with examples; Proto co-operation and commensalism with examples; Parasitism - types with examples; Ammensalism and predation -examples and their importance; Competition - intraspecific and interspecific - Gause's principle; Resource partitioning - competition release - Elegen's experiment.

1.4 Habitats

3 Hrs

Marine habitat - zonation of the sea and ecological classification of marine biota; Coastal ecology; Estuarine ecology and mangroves; Fresh water habitat - lentic and lotic systems; Ecological classification of fresh water animals; Terrestrial habitats - A brief account of biomes.

Unit - II: Environmental Biology (Contd....)

2.1 Population Ecology

2 Hrs

Population attributes - population density - natality and mortality; Age distribution, age pyramids; Population growth rate - population growth curves - logistic and exponential; Biotic Potential - Allee's principle.

2.2 Community Ecology

3 Hrs

Community structure; Ecological determinants; Ecotone and edge effect; Ecological stratification; Alpha, beta, and gamma diversity; Shannon Index and Simpson's Index; Significance of biodiversity indices.

2.3 Ecosystem

5 Hrs

Types of ecosystems with examples; Natural ecosystems; Man engineered ecosystems; Microecosystem; Biosphere and ecotone; Ecosystem - Structural components; Functions of ecosystem – productivity - primary and secondary, decomposition, energy flow – I and II laws of thermodynamics; Food chains - types with examples; Food webs with examples; Ecological pyramids - Types with examples; Nutrient cycling - nitrogen, carbon and phosphorus.

Unit - III: Environmental Pollution and Toxicology

3.1 Environmental Pollution with Reference to India

4 Hrs

Air pollution – Major air pollutants (Carbon dioxide, oxides of sulphur and nitrogen); Control of gaseous pollutants – combustion – absorption – adsorption; Control of particulate pollutants - filters, electrostatic precipitators, cyclone separators, scrubbers and catalytic converters; Air (Prevention and Control of Pollution) Act; Auto fuel policies in India - Bharath stage; A brief account of Acid rain, photochemical smog and ozone hole; Montreal protocol; Control of water pollution - Sewage/ effluent treatment – primary and secondary treatments; Water Act – River action plan; A brief account on BOD and Eutrophication; Solid waste management; Bioindicators and geoinicators - definition and examples; Environmental Protection Act 1986.

3.2 Global Impacts

1 Hr

Climate change- Global warming- Sources, effect and control measures-Kyoto protocol.

3.3 Toxicology

4 Hrs

Definition; Major subdivisions of toxicology and dose response curve; Toxicological parameters - acute and chronic toxicity; LD50, LC50; Factors influencing toxicity - route of administration, host factors-species, age, sex; Bioactivation and detoxification of xenobiotics - types of xenobiotics; Mechanism of biotransformation - phase I and II reactions; Pesticide toxicity - toxicity of organophosphate, organochloride, carbamate and pyrethroid pesticides citing two examples for each; Biomagnification - Biomagnification of DDT and Mercury; Antidotal therapy - Definition and types of antidotes with examples.

Unit - IV: Environmental Biology and Wildlife Biology

4.1 Energy Resources

2 Hrs

Types - renewable and non-renewable; Non-Conventional renewable sources of energy - solar, tidal, wind, biodiesel, bioethanol; Hydrogen – the fuel of future; Nuclear energy - Definition, advantages and disadvantages of nuclear power plants.

4.2. Zoogeography and Distribution of Wildlife

3 Hrs

Zoogeographical realms of world with climatic conditions and examples of characteristic fauna; A brief account of Wallace's line; Continuous and discontinuous distributions with examples; Barriers of dispersal - topographic and vegetation barriers - large bodies of water as barriers – climatic barriers.

4.3 Threats to Wildlife

1 Hr

Anthropogenic factors - Hunting, over harvesting, habitat destruction, degradation, habitat shrinkage, climate change; Human animal conflict.

4.3 Wildlife Conservation

4 Hrs

Agencies engaged in wildlife conservation - Government organisations and non-government organizations (NGOs); Wildlife (protection) Act 1972; CITES (Convention on International Trade in Endangered Species of Wildlife Flora and Fauna); Endangered fauna of India; IUCN categories of endangered animals; Red Data Book; Ramsar convention; CBD; Biosphere reserves - Important National Parks and Wildlife sanctuaries of India (with special emphasis on Karnataka); Projects for endangered species; Project Tiger; Project Elephant; Project Rhino; Protection of Traditional Knowledge; Biodiversity Protection Act.

VI SEMESTER B.Sc.: ZOOLOGY (PROJECT WORK/FIELD TRAINING)
BSCZOP-384: ENVIRONMENTAL BIOLOGY, TOXICOLOGY AND WILDLIFE
BIOLOGY
(2 Hours/week)

Course Outcome: Upon completion of the course the students will be able to:

1. Gain basic knowledge of collecting information about biodiversity through field visits and surveys and contribute to the understanding of local biological diversity.
2. Carryout research projects to contribute towards basic understanding of life forms in different ecosystems and environmental and wildlife issues.

Proposed topics for project work/field training:

1. Study of animal diversity in various habitats -
Gardens/croplands/grasslands/forests/ponds/rivers/streams/sea shores.
2. Bird watching and preparation of checklist of birds from different habitats.
3. Identification and study of local edible fishes.
4. Listing and identifying local butterflies and preparation of checklist of butterflies.
5. Listing and identifying common spiders and ants.
6. Listing and identifying terrestrial and fresh water molluscs.
7. Identification of molluscan shells from nearby coasts.
8. Diversity of ornamental fishes.
9. Diversity of insects.
10. Insect pests of vegetables, fruit crops, horticultural plants, paddy etc.
11. Store pests.
12. Study of biodiversity in sacred groves.
13. Study of community: By quadrat method to determine frequency, density and abundance of different species present in the community.
14. Diversity of mosquito species.
15. Diversity of wild varieties of *Drosophila*.
16. Listing and studying the use of fertilizers and pesticides in agricultural fields.
17. Identification and behavioural study of wasps.
18. Identification and study of local edible shell fishes.
19. Study of simple Mendelian traits in human populations.
20. Studying organic farming.
21. Study of soil fauna.
22. Evaluation of larvicidal / adulticidal properties of chemicals or plant extracts on mosquito or other pests.

Note: In addition to the above mentioned exercises any faunal diversity of local interest and their characteristic features/Environmental pollution problems/Toxicological problems/Human

population studies/Ecosystem studies/Utilization of energy resources/Wildlife depletion and conservation topics may be chosen for project work.

Note: During field studies care should be taken not to disturb/remove the specimens/nests etc.

Guidelines for project work

1. Project allotment should be done at the beginning of V semester and topic should be finalized in consultation with the guide by the student.
2. Each project work will be carried out as individual (preferably) or in a batch of 2/3/4 students. There shall not be more than 4 students in each group.
3. Dissertation work has to be submitted in the format prescribed.
4. Title page, Page I - Certificate, Page II - Declaration, Page III - Acknowledgements, Page IV – contents followed by the body of the dissertation.
5. Contents should include the following subheadings:
 1. Introduction with Review of Literature
 2. Materials and Methods
 3. Result and Discussion.
 4. Summary
 5. References
 6. Plates containing original photographs (Minimum 6 photos/page)
 7. Annexure (not compulsory)
6. Dissertation should contain a minimum of 20 pages excluding photographs (A4 sheets with 1inch margin on all sides, Times New Roman font, font size -12 and line spacing - 1.5).
7. A student who is going to other institutions/industry/laboratory/fields for any assistance has to take permission letter by the HOD/Principal of the college.
8. Dissertation has to be submitted individually even if the work is done in group, i.e. one student has to submit his/her dissertation exclusively. No joint author submission. The dissertation to be certified by project guide and HOD. Certified dissertation shall be submitted during practical examination which shall be evaluated by both internal and external examiners.

VI SEMESTER B.Sc.: ZOOLOGY (PRACTICAL)
BSCZOP-383: REPRODUCTIVE BIOLOGY AND DEVELOPMENTAL BIOLOGY
ENVIRONMENTAL BIOLOGY, TOXICOLOGY AND WILDLIFE BIOLOGY

SCHEME OF EXAMINATION

- I. Identify, draw labeled diagram and comment on permanent slides of developmental stages **A** and **B**. (1 from frog + 1 from chick) 2 x 6 = 12
(Identification -1 Mark, Labeled diagram - 2 Marks, Comments - 3 Marks)
- II. Identify, draw labeled diagram and comment on **C**. 04
(C-egg or sperm)
(Identification - 1 Mark, Labeled diagram -1 Mark, Comments - 2 Marks)
- III. Identify, draw labeled diagram and comment on the given placental charts/slides/ models/specimens **D** and **E**. (**D**-histological placenta & **E**-Morphological placenta)
(Identification - 1 Mark, Example - 1 Mark, Labeled diagram -1 Mark, Comments – 3 Mark) 2x6 = 12
- IV. a. Field work and preparation of dissertation 30
(To be evaluated by project guide* + internal examiner** + external examiner** each for 30 marks and average shall be taken).
* Project guide shall assess the candidate based on his/her involvement in the field work and preparation of dissertation. Marks allotment for the same shall be handed over to HOD in a sealed cover which will be transmitted to examiners.
** Distribution of marks: Introduction with review of literature - 3 Marks, Materials and methods - 4 Marks, Result and discussion - 12 Marks, Summary – 2 Marks, References – 3 Marks, Plates containing original photographs - 6 Marks)
- b. Brief oral presentation / Viva-voce (based on the contents of dissertation) 10
- V. Record 10
- Total = 80

Note: Questions must be framed as per the scheme provided.

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SCHEME OF EXAMINATION: B.Sc. - I to VI SEMESTERS (THEORY)

CORE SUBJECT: ZOOLOGY

Question No.	PART - A	Marks
I	Answer any TEN Questions out of TWELVE Questions (Give 3 questions from each unit)	10 x 2 = 20
	PART - B	
	Unit - I	
II	4 Marks Questions (Answer any TWO out of THREE)	4 x 2 = 8
III	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - II	
IV	4 Marks Questions (Answer any TWO out of THREE)	4 x 2 = 8
V	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - III	
VI	4 Marks Questions (Answer any TWO out of THREE)	4 x 2 = 8
VII	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - IV	
VIII	4 Marks Questions (Answer any TWO out of THREE)	4 x 2 = 8
IX	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7

GROUP II: ELECTIVE (SUPPORTIVE TO THE DISCIPLINE OF STUDY)
BSCZOCE-133: PARASITOLOGY AND VECTOR BIOLOGY
(To be studied in the I Semester B.Sc.)
(Hours of instruction: 2 hours per week. Total: 24 Hours)
Syllabus

Course Outcome: Upon completion of the course the students will be able to:

1. Discuss human health and diseases caused by various parasites by understanding their mode of transmission, treatment and preventive measures.
2. Understand the types of vectors and tools for vector control.

Unit - I: Parasitology

Brief account of the disease caused, mode of infection, transmission, pathogenecity and control measures of following parasites:

- | | |
|---|-------|
| 1. Protozoan: <i>Giardia</i> and <i>Trichomonas</i> . | 3 Hrs |
| 2. Helminthes: <i>Taenia</i> and <i>Ancylostoma</i> . | 3 Hrs |
| 3. Bacterial: Typhoid and Cholera. | 3 Hrs |
| 4. Viral: Hepatitis and H1N1. | 3 Hrs |

Unit - II: Vector Biology and Integrated Vector Management

1. Vectors: Introduction, types of vectors with examples; Tools for vector control, Sources –biological, chemical, adulticides and larvicides. 4 Hrs
2. Causative organism, transmission and control measures of following vector borne diseases: Filariasis, Japanese Encephalitis, Dengue and Chikungunia. 4 Hrs
3. Arthropods vectors: Diseases transmitted and control Mosquitoes with reference to Mosquitoes (*Anopheles*, *Culex*, *Aedes* and *Mansonia*), Sand fly, Fleas, Stable or Dog Fly, Tsetse Fly, Bed Bugs, Cockroach, House Fly, Human Louse, Bed Bug, Ticks and Mites. 2 Hrs
4. Avian and mammalian vectors: diseases transmitted and control measures with reference to Domestic Fowl, Rat, Bat, Dog, Cattle, Monkey. 2 Hrs

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1. A.C. Chandler & C.P. Read – Introduction to Parasitology, John Wiley & Sons Inc., 1961.
2. Apurba S. Sastry and Sandhya Bhat –Essentials of Medical Parasitology, Jaypee Brothers Medical Publishers, 2014.
3. Arora D.R. and Arora B. - Medical Parasitology, CBS Publications, 2001.
4. David D.V. and Kumara Swami - Elements of Economic Entomology, Popular Book Depot, Madras, 1988.
5. J.D. Smyth – Introduction to Animal Parasitology, Cambridge University Press, 1994.
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7. Mathews G. – Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases, Wiley-Blackwell, 2011.
8. Pedigo L.P. – Entomology and Pest Management, Prentice Hall Publication, 2002.

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**GROUP II: ELECTIVE (PROVIDING AN EXPANDED SCOPE): II SEMESTER
BSCZOCE-183: INSTRUMENTATION AND TECHNIQUES IN BIOLOGY
(To be studied in the II Semester B.Sc.)
(Hours of instruction: 2 hours per week. Total: 24 hours)
Syllabus**

Course Outcome: Upon completion of the course the students will be able to:

1. Understand the basic working principles of different instruments involved in various biological experiments.
2. Understand important biological methodologies used in understanding biological principles.

Unit - I: Microscopy and Microtechnique

1. **Microscopy:** 5 Hrs
Principle – magnification and resolution.
Types: Light, Phase contrast, Fluorescent and Electron microscopy (TEM and SEM).
2. **Microtechnique:** 3 Hrs
Introduction and procedure – fixation of tissues; Processing; embedding; microtomy; staining (simple and differential); mounting.
3. **Photomicrography:** 2 Hrs
Principle and applications.
4. **Micrometry:** 2 Hrs
Principle, types (stage and ocular) and applications.

Unit - II: Methods in Biology

1. **Centrifugation:** 2 Hrs
Principle; Types – microcentrifugation, ultracentrifugation; Applications.
2. **Chromatography:** 3 Hrs
Principle; Types – Column, Paper, Thin layer, Gas; Applications.
3. **Electrophoresis:** 3 Hrs
Principle; Types – Gel electrophoresis – Polyacrylamide and agarose; Applications.
4. **Autoradiography:** 1 Hrs
Principle and applications.
5. **Spectrophotometry:** 2 Hrs
Principle; UV-Visible Spectrophotometry; Applications.

6. **pH meter:** 1 Hr
Principle of operation and applications.

REFERENCES:

1. Arnab Banerjee, B.K Maji, Sandip Mukherjee – Some Important Tools & Techniques in Modern Biological Sciences, Lap Lambert Academic Publishing, 2017.
2. Bajpai P.K. – Biological Instrumentation and Methodology, S. Chand & Co., 2010.
3. De Robertis & De Robertis – Cell & Molecular Biology, Lea & Febiger, US., 1987.
4. Dr. Sudhir R. Wagh, Dr. Sakham B. Patil – Biological Techniques, Success Publications, 2015.
5. P.R. Yadav – Biological Techniques, Discovery Publishing House, 1993.
6. Verma and Srivastava - Advanced Practical Zoology, S. Chand Publishing, 2012.
7. M. Prakash – Understanding Bioinstrumentation, Discovery Publishing House Pvt. Ltd., 2009.
8. S. Jithendra, S. Monika, P. Anjumoni - Basic Tools & Techniques in Biotechnology, Lap Lambert Academic Publishing, 2015.

GROUP II: ELECTIVE (NURTURING STUDENT’S PROFICIENCY/SKILL):

III SEMESTER

BSCZOCE-233: AQUARIUM FISH KEEPING

(To be studied in the III Semester B.Sc.)

(Hours of instruction: 2 hours per week. Total: 24 hours)

Syllabus

Course Outcome: Upon completion of the course the students will be able to:

1. Develop the skill in setting up an aquarium, maintenance of aquarium fishes and their management.

Unit - I: Introduction to Aquarium Fish Keeping

1. **Biology of Aquarium Fishes** 6 Hrs
Importance and scope of aquarium fish keeping; Exotic and endemic species of aquarium fishes; Common characters and sexual dimorphism in aquarium fishes: Guppy, Molly, Sword tail, Gold fish, Angel fish, Koi, Gourami, Zebra fish, Fighter fish.
2. **Aquarium Setup** 6 Hrs
Construction and preparation – size, shape, substrate, ornamental aquatic plants, bio-filters, aerators; Accessories for fish tank - hood and light, nets, suction tube, feeding cups and breeding traps; Water quality management - pH, hardness, salinity, oxygen, carbon dioxide, chlorine, ammonia and temperature.

Unit - II: Aquarium Management

1. **Food, Feeding and Reproduction** 6 hrs

Nutritional requirement of fishes, fish feed, composition of fish feed; Feeding methods- live feed, artificial feed; Reproductive Biology of Gold fish, Fish seed collection.

2. Transportation and Disease Management

6 hrs

Live fish transport - fish handling, packing and forwarding techniques; Aquarium fish diseases - Bacterial, Viral, Fungal and Protozoan infections, treatment and control.

REFERENCES:

1. Amita Saxena - Aquarium Management, Daya Publishing House, 2003.
2. B. Ahilan, N. Felix, R. Santhnam - Textbook of Aquariculture, Daya Publishing House, 2008.
3. C.S. Tharadevi, K.V. Jayashree, N. Arumugam - Home Aquarium and Ornamental Fish Culture, Saras Publication, 2015.
4. David Alderton - Encyclopedia of Aquarium & Pond Fish, Penguin, UK, 2011.
5. Biju Kumar & M. Alappat - A Complete Guide to Aquarium Keeping, Low Price Publications, 1995.
6. H. J. Alappat & Biju Kumar - Aquarium Fishes: A Colourful Profile, B.R. Publishing Corporation, 2011.
7. Ulrich Schliewen - Tropical Freshwater Aquarium Fish from A to Z, Barron's Educational Series Inc., U.S., 2005.
8. Uma, Felix & Gopalakannan - Fish Diseases & Management, Tamil Nadu Dr. Jayalalitha University, 2018.
9. Rolf Geisler - Aquarium Fish Diseases, TFH Publications, 1963.

GROUP II: ELECTIVE (ENABLING AN EXPOSURE TO SOME OTHER DISCIPLINE/DOMAIN):

IV SEMESTER: BSCZOCE-283: VERMITECHNOLOGY

(To be studied in the IV Semester B.Sc.)

(Hours of instruction: 2 hours per week. Total: 24 hours)

Syllabus

Course Outcome: Upon completion of the course the students will be able to:

1. Start self employment in vermitechology so that he/she will specialize in handling earthworms for the betterment of humanity.
2. Adopt ways of treating solid waste to make it useful for agriculture.

Unit - I: Biology and Ecology of Earthworms

1. Introduction, Systematic position, General characteristics of earthworm- habit, habitat, morphology (body organization, shape, size, clitellum, external openings). 4 Hrs
2. Ecological distribution of species (Epigeic, Endogeic, Anecic), Food habits (Detrivores, Geophages) and food preferences of earthworms, Reproduction (Life cycle, Regeneration). 4 Hrs

3. Importance of Earthworm in Agriculture, Waste management and as a Bio-indicator; Role of earthworms in soil structure – Carbon, Nitrogen and Phosphorous transformations. 4 Hrs

Unit - II: Vermiculture and Vermicomposting

1. Selection of suitable earthworm species, important features and examples (*Eudrilus euginae*, *Eisenia fetida*, *Peryonix excavates*, *Lumbricus terrestris*). 4 Hrs
2. Physical factors - moisture, temperature, pH, aeration, light; Biological factors- Types of organic wastes (city garbage, city refuges, agricultural wastes, agro-industrial wastes, weeds, animal dung); Chemical factors affecting the earthworm culture. 4 Hrs
3. Vermicomposting methods- Small scale (Pot method, pipe method) and Large scale (pit method, heap method) vermicomposting units; Primary decomposition (Preparation of waste material), Secondary decomposition (introducing earthworms and daily maintenance), Harvesting of compost, Extraction of vermiwash. Uses of Vermicompost and vermiwash. 4 Hrs

REFERENCES:

1. A. Mary Violet Christy – Vermitechnology, MJP Publishers, 2008.
2. Arvind Kumar – Verms & Vermitechnology, APH Publishing, 2005.
3. Avnish Chauhan - Vermitechnology, Vermiculture, Vermicompost and Earthworms, Lap Lambert Academic Publishing, 2012.
4. M. Seethalekshmy, R. Santhi – Vermitechnology, Saras Publications, 2012.
5. Madhab Chandra Dash - Tools For Vermitechnology, I.K. International Publishing House, 2011.
6. S.M. Singh - Earthworm Ecology & Environment, International Book Distributing Co., 2009.
7. Shweta Yadav, Vinay Kumar Singh - Vermitechnology: Rebuilding of Sustainable Rural Livelihoods (Global Agriculture Developments), Nova Science Publishers Inc., 2014.
8. Yadav Shweta - Empowerment of Weaker Section of Society Through Vermitechnology, Lap Lambert Academic Publishing, 2014.

SCHEME OF EXAMINATION

Elective Papers (BSCZOE-133 to ZOE-283)

Question No.	PART - A	Marks
I	Answer any FIVE Questions out of SIX Questions (Give 3 questions from each unit)	5 x 2 = 10
	PART - B	
	Unit - I	
II	4 Marks Questions (Answer any TWO out of THREE)	4 x 2 = 8
III	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - II	
IV	4 Marks Questions (Answer any TWO out of THREE)	4 x 2 = 8
V	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
