

B.Sc. Semester – III
DSC- BZO3T05 : Life and Diversity of Animals - Chordates
(Protochordata to Amphibia)
Theory-2 Credits + Practical- 1 Credits

Course Outcomes: Students should be able to

- CO 1.** Describe classes and orders of phylum Chordata.
- CO 2.** Identify, Classify various animals of the Phylum Chordata.
- CO 3.** Differentiate between Protochordate and higher Chordates upto Amphibia based on their characters.
- CO 4.** Analyze the anatomy and physiology of protochordates, agnathans, pisces and amphibians.
- CO 5.** Create interlinking and mapping between various chordate groups.

Unit – I **7.5 hrs.**

- 1.1 Origin and ancestry of Chordata
- 1.2 General character and classification of Chordata upto classes, affinities of protochordates with Hemichordata and Agnatha.
- 1.3 *Herdmania*: digestive system, ascidian tadpole and retrogressive metamorphosis.
- 1.4 *Amphioxus*: digestive system, sense organs (Kolliker's pit and infundibular organ) and protonephridia.

Unit – II **7.5 hrs.**

- 2.1 Vertebrata: General characters, affinities of vertebrata with protochordata.
- 2.2 Petromyzon: Digestive system, Respiratory system, Reproductive system.
- 2.3 Ammocoete larva, General characters of Myxine.
- 2.4 Ostracoderm: General characters with examples, reason of extinction.

Unit – III **7.5 hrs.**

- 3.1 Pisces: Salient features of Chondrichthyes and Osteichthyes.
- 3.2 General characters of Dipnoi: *Neoceratodus*, *Protopterus*, *Lepidosiren*.
- 3.3 *Labeo rohita*: External features, Respiratory System, Urinogenital system.
- 3.4 Migration in fishes (Types and causes).

Unit – IV **7.5 hrs.**

- 4.1 Amphibia: Origin of Amphibia, affinities with Pisces.
- 4.2 Parental care and Neoteny in Amphibia.
- 4.3 Axolotl Larva, Hibernation and aestivation in Anura.
- 4.4 Frog (*Rana tigrina*): Circulatory system, Respiratory system.

BZO3P05: Practical –Life and Diversity of Animals – Chordates (Protochordata to Amphibia) (1 Credit)

- 1. Identification, classification , distinguishing characters and adaptive features of
 - I. Urochordata : *Herdmania*, *Salpa*
 - II. Cephalochordata : *Amphioxus*
 - III. Cyclostomata : *Petromyzon*
 - IV. Pisces : *Pristis*, *Torpedo*, *Notopterus*, *Ophiocephalus*, *Catla*, *Clarius*.

- V. Amphibia: *Ichthyophis* , *Bufo*, *Salamander*.
2. Anatomical observation of fish-
 - i. Digestive system
 - ii. Reproductive system
 - iii. Brain
3. Study of permanent slides-
T.S. *Amphioxus* through pharynx, Intestine, Gonad and Caudal region; V.S. skin, T.S. Testis, T.S. Ovary of Frog.
4. Permanent stained preparation: fish scales.
5. Submission of charts of interlinking of different groups of chordates up to Amphibia.

Practical Examination Scheme

Distribution of marks (For SEE)

Total Marks: 25

1. Identification and comments on spots.	10
2. Draw and label Brain/ Digestive system/ Reproductive system of fish.	05
3. Permanent stained preparation of fish scales.	05
4. Submission of certified practical record	02
5. Viva voce	03

Reference Books

1. Text book of Zoology vol II – Parker and Haswell
2. T. B. of Vertebrate Zoology -S. N. Prasad
3. Chordate Zoology –E. L. Jorden and P. S. Verma
4. Vertebrate Zoology – Vishwanath
5. Zoology of Chordates – Nigam H. C.
6. Phylum: Chordata – Newman H.H.
7. Biology of Vertebrates –Walter & Sayles
8. The Vertebrate Body – Romer A. S.
9. Comparative Anatomy of the Vertebrates – Kingslay J. D.
10. The Biology of Amphibia – Noble G. K.
11. Snakes of India – Gharpura K. G.
12. Life of Mammals – Young J.Z.
13. Modern textbook of Zoology Vertebrates – Kotpal R. L.
14. Introduction to Chordates – Majupuria T.C.
15. Vertebrate Zoology – Dhami & Dhami
16. T. B. Vertebrate Zoology – Agrawal
17. Protochordates – Chatterjee & Pandey
18. Protochordates – Bhatia
19. T. B. of Chordates – Bhamrah and Juneja
20. Chordate Anatomy –M.P. Arora
21. The Chordates – Alexander.

B.Sc. Semester – III
DSC- BZO3T06: Genetics
Theory 2 credits + Practical 1 credit

Course Outcomes: Students will able to

CO 1. Understand the Fundamental Principles of Genetics: Explain Mendelian inheritance, the Chromosome Theory of Inheritance, mitochondrial DNA and plasmids, and genetic variation and mutation, distinguish various chromosomal aberrations, recognize types of mutations (point mutations, frameshift), and evaluate their roles in genetic diversity and disease.

CO 2. Comprehend the Mechanisms of Genetic Inheritance and Gene Structure: Explore genetic inheritance mechanisms, gene structure, chromosomal mapping concepts, and cytoplasmic inheritance. Analyze pedigree analysis for autosomal and X-linked traits to identify inheritance patterns.

CO 3. Analyze Genetic Variation and Evolutionary Dynamics: Apply the Hardy-Weinberg principle to study genetic equilibrium and the impact of factors such as mutation, selection, and genetic drift on population genetics, Explain the genetic basis of speciation, adaptation, and evolutionary processes, Use quantitative genetics to explore polygenic traits, heritability, and their role in natural selection and evolution.

CO 4. Examine Human Genetics and Genetic Disorders: Interpret human karyotypes and identify chromosomal and genetic disorders, Understand the inheritance patterns of single-gene and multifactorial disorders, Discuss the ethical considerations in genetic counseling, genetic testing, and biotechnology, especially in the context of human health.

CO 5. Explore Advanced Topics in Genetics and Their Applications: Analyze the genetic basis of cancer, oncogenes, and tumor suppressor genes, and the role of mutations and environmental factors in cancer development, Discuss the role of epigenetics and environmental influences on gene expression and development, Evaluate the applications of gene therapy, agriculture, and biotechnology, addressing ethical and societal implications.

Unit 1

7.5 hrs.

1.1 Mendelian Genetics: Mendel's laws of inheritance (Law of segregation, Law of independent assortment), Monohybrid and dihybrid crosses, Test cross and back cross.

1.2 Interaction of genes: Epistasis: dominant epistasis (12:3:1) e.g. coat colour in dog (Brown dog X white dog) ; recessive epistasis (9:3:4) e.g. coat colour in mice. Codominance e.g. Roan cattle; incomplete dominance e.g. Andalusian fowl.

1.3 Extracellular genome: Presence and functions of mitochondrial DNA. Plasmids- Types and significance.

1.4 Genetic Variation: Chromosomal aberrations (deletions, duplications, inversions, translocations), Spontaneous and induced mutations. Types of point mutation- deletion, insertion, substitution, transversion, transition, frameshift mutation.

Unit II

7.5 hrs.

2.1 Chromosome Theory of Inheritance: Linkage and crossing over: types and significance, Chromosomal mapping in eukaryotes.

2.2 Cytoplasmic inheritance: *Kappa* particles in *Paramecium*, CO₂ sensitivity in *Drosophila*, milk factor in mice.

2.3 Pedigree analysis: Pedigree analysis, Autosomal Recessive Inheritance, Autosomal Dominant Inheritance, X-linked recessive Inheritance, X-linked dominant Inheritance, and Y linked inheritance.

2.4 Concepts of genes: Classical concept of gene, Molecular concept of gene- Cistron, Muton and Recon.

Unit III

7.5 hrs.

3.1 Population Genetics: Gene pool and allele frequency, Hardy-Weinberg principle and its applications, Factors affecting genetic equilibrium (mutation, migration, selection, genetic drift).

3.2 Quantitative Genetics: Polygenic inheritance and continuous variation e.g. Skin colour in human, eye colour in human, sickle-cell anaemia. Inbreeding and outbreeding, hybrid vigor.

3.3 Speciation and Evolution: Species concepts and speciation mechanisms (Parapatric, Sympatric and Allopatric Speciation), Adaptive radiation, divergent and convergent evolution.

3.4 Human Genetics: Karyotyping and chromosomal disorders (Down syndrome, Turner syndrome, Klinefelter syndrome), Genetic counseling and prenatal diagnosis (Aminocentesis and Chorionic villi test).

Unit IV

7.5 hrs.

4.1 Genetic Disorders and Inborn Errors of Metabolism: Single-gene disorders (e.g., cystic fibrosis, sickle-cell anemia), Inborn errors of metabolism (e.g., phenylketonuria, alkaptonuria).

4.2 Cancer Genetics: Mechanism of activation of oncogenes (point mutation, gene amplification and chromosomal translocations); mechanism of inactivation of tumor suppressor genes (mutation, deletions and epigenetic silencing).

4.3 Epigenetics and Environmental Influence on Genes: Role of environment in gene expression, Epigenetic changes in response to environmental stimuli, Developmental plasticity and gene-environment interactions, Impact of nutrition, stress, and toxins on gene expression.

4.4 Applications of Genetics in Medicine and Agriculture: Gene therapy: principles and challenges, Genetic modification in livestock; Ethical, social, and legal issues in genetic research and biotechnology.

BZOP06: Practical- Genetics (1 Credit)

1. To study monohybrid cross ratio using beads.
2. To study dihybrid cross ratio using beads.
3. Construct chromosomal maps in eukaryotes by calculating crossover frequencies.
4. Study of normal human karyotype (Normal male and female).
5. Study of characters and karyotypes of Down Syndrome.
6. Study of characters and karyotypes of Klinefelter Syndrome.

7. Study of characters and karyotypes of Turner Syndrome.
8. Study of the genetic traits (Hardy Weinberg law) in human being (Tongue rolling, ear lobe, PTC taster/ non taster).
9. The field visit to Institute/Laboratory/ agricultural field/ animal husbandry etc. for understanding of gene therapy techniques or the genetic modification of crops or livestock.

Reference Books

1. Genetics and Genetic Engineering – Joshi
2. Genetic Engineering and its applications – Joshi
3. Genetics – Gardener
4. Genetics – Winchester
5. Genetics – Gupta
6. Principles of Genetics – Sinnot Dunn, Dobzansy
7. Genetics – Ahluwalia
8. Genetics – Sarin
9. Elementary Genetics – Singleton
10. General Genetics – SRb, Owen & Edger
11. Genetics – Alenberg
12. Foundation of Genetics – Pai
13. Genetics - Stickberger
14. T. B. of Genetics- Veerbala Rastogi
15. Gene VI by Benjamin Lewis, Oxford press
16. Gene VIII by Benjamin Lewis, Oxford press
17. Genetics Vol. I and II by Pawar C. B., Himalaya publication

B.Sc. Semester III
Generic Elective/Open elective
BGO3T05: Animal Husbandry
Theory: 2 credits

Course Outcomes: After the completion of course students will be able to

- CO 1.** Understand the basic concepts and classifications in poultry, including the systematic position, habitat, and morphology of *Gallus gallus domesticus*.
- CO 2.** Identify and differentiate among various poultry breeds, such as American, Mediterranean, English, Asiatic, and Indian breeds.
- CO 3.** Demonstrate knowledge of brooding and rearing techniques, including housing systems, nutritional needs, and equipment for poultry.
- CO 4.** Recognize common poultry diseases, understand their causative agents, symptoms, and implement prevention and control measures.
- CO 5.** Analyze the composition, nutritive value, and economic importance of poultry products, including eggs and meat.
- CO 6.** Gain insights into the economic aspects of poultry farming and its role in sustainable agricultural practices.

Unit 1

7.5 hrs.

- 1.1 Introduction:** Definition and concept of poultry, Types of poultry (Chickens, Turkeys and Ducks and Emu)
- 1.2 Types of Poultry Breeds: Chicken** (White Plymouth Rock, White Leghorn, Brahma, Aseel), Turkeys (.)
- 1.3 Brooding and Rearing:** Natural vs. artificial brooding, Housing, equipment, and poultry house systems and Poultry nutrition.
- 1.4 Poultry Diseases and Control:** Viral: Ranikhet disease; Bacterial: Pullorum disease; Fungal: Aspergillosis (Brooder pneumonia); Protozoan: Coccidiosis; Ecto-parasites: Tick, Shaft louse.

Unit II

7.5 hrs.

- 2.1 Poultry Products:** Eggs: Composition and nutritive value; Meat: Composition and nutritional value
- 2.2 Economics of Poultry:** International, National and State wise (Maharashtra) perspectives.
- 2.3 Goatary:** Introduction and Indian breeds, distribution and characteristics
- 2.4 North – west and Central region:** Jamunapari, Barbari, Beetal (Amritsari), Surti, Marwari, Mehsana Jhakrana.

Unit III

7.5 hrs.

- 3.1 Breed of goat in South Peninsular region-** Osmanabadi, Malbari, Sangamneri.
- 3.2 Breed of goat in Eastern region-**Bengal, Ganjam.
- 3.3 Breed of goat in Northern – temperate region-** i. Gaddi.
- 3.4 Reproductive performance :** Reproduction, Feeding habits of goat, Nutrients requirements of goat, Feeding of kids, Feeding of pregnant goat, Feeding of lactating goat.

Unit IV

7.5 hrs.

- 4.1 Handling of Goats:** Mustering, drafting (operating and separating), capturing and training of goats.
- 4.2 Castration, Dehorning, Care of feet, Housing, Care of kids.**

4.3 Diseases of goat: Symptoms and treatment of Peste des petits ruminants (PPR), Contagious ecthyma (orf), Paratuberculosis, Goat pox.

4.4 Economics of Goatery: Global economic perspective, National economic perspective and Maharashtra state level perspective.

Reference Books

1. Poultry production – R. A. Singh. Kalyani publishers, New Delhi.
2. Animal Husbandry- G. C. Banerjee. Oxford and IBH publishing Co.
3. Poultry introduction- R. A. Singh. Kalyani publishers, New Delhi.
4. A textbook of Animal Husbandry – G. C. Banerjee. Oxford and IBH publishing Co.Pvt. Ltd. New Delhi.
5. Economic Zoology- Manju Yadav. Discovery publishing house, New Delhi.
6. Applied Entomology- Manju Yadav. Discovery publishing house, New Delhi.
7. Economic Zoology- Shukla and Upadhyay, Rastogi publication.
8. Economic Zoology vol. I & II - P. D. Srivastava and N. C. Pant. Commercial Publication Bureau, New Delhi.

B.Sc. Semester III
Vocational Skill Course (VSC)
BVS3P05: Aquarium Preparation and Maintenance
Practical 2 credits

Course outcomes- After the completion of course students will able to

CO 1. Aware of the vast potential and vocational opportunities involved in aquarium fabrication and management.

CO 2. The learner gains the scientific method of fabricating and maintaining an aquarium .

CO 3. Learner can learn the common troubleshooting mechanisms in aquarium management.

CO 4. Students can analyse the optimum physical and chemical condition of water required for aquarium.

CO 5. Learner also acquainted with fish food.

List of Experiments

1. Design and construction of aquarium.
2. Aquarium fabrication- shape, size, volume, type of glass, cutting of glass, preparation of glass tank, adhesives used.
3. Aquarium floor bed setting type- size of pebbles, gravels, granites , sand used for bed setting.
4. Filters, Aerators, other aquarium accessories, aquarium plants.
5. Rearing and nurturing live Bearers aquarium fishes.
6. Preparation of Egg layers for aquarium fishes.
7. Water quality Analysis in aquarium systems - sources of water, storage, temperature, pH, dissolved oxygen, dissolved carbon dioxide, hardness, turbidity in aquariums.
8. Preparation of feed for aquarium fishes.

Practical Examination Scheme

Distribution of marks (For SEE)

	Total Marks: 50
1. Identification and comment on spots (5 spots-2marks each)	10
2. Design, construction and Fabrication of an Aquarium	10
3. Setting up of an Aquarium and decoration	10
4. Analysis of Parameters DO/ CO ₂ / pH/ Alkalinity.	10
5. Study Tour/Field Visit report	05
6. Viva Voce	05

Reference Books

1. Aquarium construction, keeping and maintenance- Arman U. Muzaddadi and Sagar C. Mandal.
2. Simple guide to freshwater aquarium- David E. Boruchowitz.
3. Aquariums and Aquarium Fish: A Practical Guide to Identifying and Keeping Freshwater and Marine Fishes- Mary Bailey and Gina Sandford.
4. Encyclopedia of Aquarium and Pond Fish-David Alderton.
5. Aquarium care and maintenance- Saroj K. Swain.

B.Sc. Semester- IV
DSC- BZO4T07: Life and Diversity of Animals- Chordates
(Reptilia to Mammalia)
Theory 2 Credits + Practical- 1 Credit

Course outcomes: By the completion of the course the students will be able to

- CO 1. Describe, explain characters, classification of Reptile. Could analyze general pattern of different system of reptile.
- CO 2. Describe, explain characters, classification of Aves. Could analyze general pattern of different system of Aves.
- CO 3. Describe, explain characters, classification of Mammalia. Could analyze general pattern of different system of Mammalia.
- CO 4. Compare integuments, urinogenital systems, heart and aortic arches in Reptilia, Aves and Mammalia. Also describe and analyze autonomous nervous system in Mammalia.

Unit – I

7.5 hrs.

- 1.1 Reptilia: General characters of Reptilia, Classification of Reptilia on the basis of temporal vacuities.
- 1.2 Calotes: External features, Digestive system, Respiratory system,
- 1.3 Structure and function of CNS (Brain and spinal cord).
- 1.4 Identification of Poisonous snakes and biting mechanism of snakes.

Unit – II

7.5 hrs.

- 2.1 Aves: General characters and classification of Aves on the basis of carina (Ratitae and Carinatae).
- 2.2 Columba livia: External features, Digestive system, Respiratory system,
- 2.3 Structure and function of CNS (Brain and spinal cord)
- 2.4 Migration in Birds, Flight adaptation in birds

Unit – III

7.5 hrs.

- 3.1 General characters of Mammalia. Comparison of Prototherians, Metatherians and Eutherians.
- 3.2 Aquatic, arboreal and Volant adaptation in mammals.
- 3.3 Rabbit: Structure and function of digestive and respiratory system.
- 3.4 Rabbit: Structure and function of CNS (Brain and spinal cord).

Unit – IV

7.5 hrs.

- 4.1 Comparative accounts of integuments and its derivatives in Reptilia, Aves and Mammalia.
- 4.2 Comparative accounts of urinogenital systems in Reptilia, Aves and Mammalia.
- 4.3 Comparative accounts of heart and aortic arches in Reptilia, Aves and Mammalia.
- 4.4 Autonomous nervous system in mammals (Sympathetic and Parasympathetic).

BZO4P07: Practic- Life and Diversity of Animals- Chordates (Reptilia to Mammalia)
(1 Credit)

1. **Study of museum specimens** (Classification of animals up to orders)

Reptilia: Draco, Chamaeleon, Pharynosoma, Testudo, Russell's viper, Naja, Krait, Hydrophis, Crocodile, Alligators.

Aves: Owl, Woodpecker, pigeon, Kingfisher, Kite, Duck, Parakeet.

Mammals: Squirrel, Mongoose, Loris, Bat, Rabbit, Dolphin, Whale.

2. Study of Axial skeleton and Appendicular skeleton of Fowl and Rabbit.
3. Dissections are to be demonstrated only by the virtual/ICT tools.
Anatomical observations of digestive system , reproductive system and brain in fowl by diagram, model and ICT tools.
Anatomical observations of digestive system , reproductive system and brain in Rat by diagram, model and ICT tools.
4. Collection and study of different types of feathers: Quill, Contour, Filoplume, Down.
5. Mounting of striated muscles and cartilage procured from slaughter house.

Practical Examination Scheme

Distribution of Marks (for SEE)

Total Marks: 25

1. Identification and comments on spots (6 Museum specimens + 4 bones)	10
2. Draw and give labels of given systems of given animal	05
3. Mounting of given material	02
4. Submission of certified practical record	03
5. Viva Voce	05

Reference Books:

1. Practical Zoology – Vertebrata.- S.S. Lal,
2. A manual of Practical Zoology – Chordata- P.S.Verma.
3. Chordate Zoology’ - E.L.Jordan and P.S. Verma, S. Chand Publication.
4. Chordata – Mohan P.Arora, Himalaya Publishing House Pvt. Ltd.
5. Text book of Vertebrates- Marshal, Parker and Haswell, ELBS and McMillan, England.
6. The Vertebrate Body, Sixth edition,- Alfred Sherwood Romer. Thomas, S. Pearson, CBS College Publishing, Saunders College Publishing.
7. The Life of Vertebrates, 3rd edition, J.W. Young, d, Oxford University press.
8. Vertebrate Life, 6th edition- Harvey Pough F, Christine M. Janis, B. Heiser, , Pearson, Education Inc.
9. Modern textbook of Zoology Vertebrates – Kotpal R. L., Rastogi Publication.

B.Sc. Semester – IV
DSC-BZO4T08: Developmental Biology
Theory- 2 credits + Practical- 1 credit

Course outcomes: By the completion of the course the students should be able to

- CO 1.** Describe, explain and differentiate various stages, pattern of development in protostomes and deuterostomes. They could also be able to differentiate different types of development in insects, different types and stages of gametogenesis and different types of eggs.
- CO 2.** Describe, explain and differentiate various phases of fertilization, cleavage. They could also describe, explain different stages of development in *Amphioxus* and Frog.
- CO 3.** Describe, explain and differentiate different stages of development in Chick up to gastrulation. They could also understand, describe, explain and differentiate structure and function of extra embryonic membranes in Chick
- CO 4.** Describe, explain and differentiate different types of placenta. Also analyse development of Mammalia up to Gastrulation. They will be able to differentiate totipotency and pluripotency and analyse axis formation in Mammals.

Unit – I

7.5 hrs.

- 1.1** Principle stages of development, Development pattern of protostomes, Development pattern of deuterostomes.
- 1.2** Types of development: Ametabolous, hemimetabolous and holometabolous development in insects.
- 1.3** Gametogenesis: Spermatogenesis, spermiogenesis, oogenesis.
- 1.4** Types of eggs: microlecithal egg, mesolecithal egg, megalecithal egg, isolecithal egg, telolecithal egg, cleidoic egg and non-cleidoic egg.

Unit II

7.5 hrs.

- 2.1** Fertilization: Mechanism of fertilization (Capacitation, Acrosome reaction, Recognition of sperm and egg, Gamete fusion and prevention of polyspermy, Amphimixis).
- 2.2** Cleavage: Type of cleavage; Meroblastic cleavage (Superficial and Discoidal), holoblastic cleavage; Pattern of cleavage (Radial, Spiral, bilateral and rotational cleavage).
- 2.3** Development in *Amphioxus*: Egg, Cleavage, Blastulation, Fate map and Gastrulation.
- 2.4** Frog Embryology – Egg, Cleavage, blastulation, Fate map, Gastrulation.

Unit –III

7.5 hrs.

- 3.1** Development in Chick: Structure of egg, fertilization, cleavage, blastulation, fate map.
- 3.2** Gastrulation: Formation of primitive streak, Completion of endoderm, Regression of primitive streak, Epiboly of endoderm.
- 3.3** Development of extra embryonic membranes (Chorion, Amnion, Allantois and yolk sac) in chick.
- 3.4** Significance of extra embryonic membranes (Chorion, Amnion, Allantois and yolk sac) in chick.

- 4.1** Blastocyst and implantation in Mammals; Types of placenta on the basis of morphological and histological structure; functions of placenta.
- 4.2** Cleavage in mammals (Compaction), Escape of Embryo from Zona pellucida, Gastrulation.
- 4.3** Axis formation: Anterior- posterior axis formation (Role of node and anterior visceral endoderm in anterior – posterior axis formation, hox code hypothesis); Dorso-ventral and left-right axes formation.
- 4.4** Stem cells: Pluripotency, totipotency; sources, types and use of stem cells in human welfare.

BZOP08: Practical-Developmental Biology (1 Credit)

- 1 Study of permanent slides of Frog embryology: T.S. Blastula, T.S. Gastrula, T.S. Neurula, T.S. tadpole passing through internal and external gill stage
2. Study of permanent slides of chick embryology W.M.: 18 hrs, 24 hrs, 30 hrs, 36 hrs, 72hrs/
3. Study of stages of gametogenesis in rat/frog, (Permanent Stained Slides).
4. Study of different types of animal eggs.
5. Study of developmental stages (Life Cycle) of Cockroach, Butterfly, Frog (Any Four).
6. Study of developmental stages of Lymnaea.
7. Developmental stages of frog: Cleavage, blastula, gastrula, neurula, and tadpoles through available resources.
8. Study of chick embryo at different hours of incubation by permanent slides.
9. Study of different types of placenta with suitable histological slides or visual diagrams.

Reference Book

1. Developmental Biology- Scott F. Gilbert, 2nd Edition, Sinauer Associates Inc. Publishers, pp.842
2. Developmental Biology- Scott F. Gilbert, 6th Edition, Sinauer Associates Inc. Publishers, pp.842
3. Embryology and Physiology in Annelids and Arthropods- D.T. Anderson, Pregmon press, New York, pp497
4. Metamorphosis: A problem in Developmental Biology-Lawrence I. Gilbert and Earl Frieden, Plenum press, New York, pp577

B.Sc. Semester – IV
Generic/ Open Elective
BGO4T06: Communicable Diseases
Theory: 2 credits

Course Outcomes: By the completion of the course the students will able to

CO 1 Describe, explain about WHO and NCDC and could analyse Influenza and Covid 19.

CO 2 Describe, explain about Bacterial diseases like Tuberculosis, Pertusis, Typhoid.

CO 3 Describe, explain fungal diseases like Ring worm and Athlete's foot as well as protozoan caused disease like Giardiasis.

CO 4 Describe, explain vector borne diseases like Malaria, sleeping sickness and filariasis.

Unit I

7.5 hrs.

- 1.1 Communicable diseases: Definition, Pandemic, Endemic and Epidemic diseases, World Health Organization (WHO), National Centre of Disease Control (NCDC).
- 1.2 Multiplication of virus (Lytic and lysogenic), dual (non-living and living) character of virus.
- 1.3 Hepatitis: Hepatitis B virus, Epidemiology of Hepatitis, transmission, symptoms, prevention, diagnosis and treatment.
- 1.4 Covid 19: SARS-CoV-2 virus, epidemiology of Covid 19, transmission, symptoms, prevention, diagnosis and treatment.

Unit II

7.5 hrs.

- 2.1 Types of bacteria based on staining property and shapes.
- 2.2 Tuberculosis: *Mycobacterium tuberculosis*, Epidemiology of tuberculosis, transmission, symptoms, prevention, diagnosis and treatment.
- 2.3 Pertussis (Whooping Cough): *Bordetella pertussis*, Epidemiology of tuberculosis, transmission, symptoms, prevention, diagnosis and treatment.
- 2.4 Typhoid: *Salmonella typhi*, Epidemiology of typhoid, transmission, symptoms, prevention, diagnosis and treatment.

Unit III

7.5 hrs.

- 3.1 Fungus: Chytrids, Bread molds, Yeast, Club fungi.
- 3.2 Ring worm: Pathogen of ringworm (Trichophyton, Microsporum, and Epidermophyton), Epidemiology of ringworm, transmission, symptoms, prevention, diagnosis and treatment.
- 3.3 Athlete's foot (Tinea pedis): Dermatophytes, Epidemiology of Athlete's foot, transmission, symptoms, prevention, diagnosis and treatment.
- 3.4 Giardiasis: *Giardia duodenalis*, Epidemiology of Giardiasis, transmission, symptoms, prevention, diagnosis and treatment.

Unit IV

7.5 hrs.

- 4.1 Insect vector: General morphology and life cycle of Mosquitoes (*Anopheles*), Sandfly (*Phlebotomus sp.*), Tsetse fly (*Glossina sp.*).
- 4.2 Malaria: *Plasmodium sp.* Epidemiology of malaria, transmission, symptoms, prevention, diagnosis and treatment.

- 4.3 Sleeping sickness: *Trypanosoma*, transmission, symptoms, prevention, diagnosis and treatment.
- 4.4 Lymphatic Filariasis: *Wucheria bancrofti*, Epidemiology of filariasis, transmission, symptoms, prevention, diagnosis and treatment.

Reference Book

1. Principles and practice of infectious diseases- John E. Bennet, Raphael Dolin, Martin J. Blaser, 9th Edition
2. Communicable diseases- A Global perspective, 6th Edition, Roger Webber, CABI, 392 pp.
3. Comprehensive Textbook of infectious diseases- MI Sdulla, Sayema A. Uduman, 2nd Edition, Jaypee Brothors, 534 pp.
4. Infectious Diseases from prevention to control. Yvette S. Brewer, Nova Science Publication.

B.Sc. Semester – IV
Generic/ Open Elective
BGO4T06: Biostatistics
Theory: 2 credits

Course Outcomes: By the completion of the course the students will be able to

CO 1. Describe, explain and analyse data and sample as well as data collection and data presentation.

CO 2. Describe, explain, analyse data diagrammatic presentation and mean and median as measure of central tendency.

CO 3. Describe, explain mode as measure of central tendency as well as measure of dispersion along with correlation and regression.

CO 4. Describe, explain probability, concept of test of hypothesis and biostatistical software.

Unit I

7.5 hrs.

- 1.1 Significance of Biostatistics, concept of population and sample, types of sampling.
- 1.2 Types of data: Qualitative or categorical data (Nominal data and ordinal data), Quantitative data (Discrete and continuous data).
- 1.3 Data collection method: Primary data collection method- Qualitative method (Time series analysis, smoothing technique, barometric method), Quantitative method (Surveys, Polls, Interviews, Delphi technique, focus groups, questionnaire), Secondary data.
- 1.4 Presentation of data: Tabulation of data (Essential parts of table, Types of tabulation-Simple tabulation/ one way tabulation, double tabulation/ two way tabulation and complex tabulation).

Unit II

7.5 hrs.

- 2.1 Methods of tabulation (Direct tally method, Card sort and count method, list and tally method).
- 2.2 Diagrammatic data presentation: Bar diagram (Simple, multiple, component bar diagram), pie chart, frequency diagram, histogram, frequency polygon.
- 2.3. Measure of Central tendency: Mean (Types of mean- Arithmetic, Geometric and Harmonic), Calculation of Arithmetic mean for ungrouped data and grouped by direct method and assumed mean method.
- 2.4 Median: Definition of median, Calculation of Median for ungrouped data (odd and even number data) and grouped data.

Unit III

7.5 hrs.

- 3.1 Mode: Definition of mode, calculation of mode for ungrouped data and grouped data, comparison between mean, median and mode.
- 3.2 Measure of Dispersion: Absolute measure of dispersion (Range, Variance, Mean Deviation, Standard Deviation and Standard Error).
- 3.3 Relative measure of dispersion: Coefficient of range, coefficient of variation, coefficient of standard deviation.
- 3.4 Correlation, Regression, Comparison between Correlation and Regression, Coefficient of Correlation.

Unit IV

7.5 hrs.

- 4.1 Probability: Definition of probability, Types of probability (Theoretical, Experimental and Axiomatic probability), Events in probability (Impossible events/ sure events, simple events, compound events, dependent and independent events, mutually exclusive and mutually not exclusive events, complementary events).
- 4.2 Addition rule of probability (for mutually exclusive events and for mutually not exclusive events), Multiplication rule of probability (for dependent events and for independent events).
- 4.3 Test of hypothesis: Null hypothesis, Alternate hypothesis, Student t test (Assumptions, importance and examples).
- 4.4 Biostatistical Software: MS Excel, GraphPad Prism, MATLAB, Minitab, SPSS.

Reference Books

- 1. Basics of Biostatistics- A.P. Kulkarni, 2nd Edition, CBS publishers and distributors
- 2. Fundamentals of Biostatistics- Khan and Khanum Shiba Khan, Ukaaz Publication, Hyderabad, India.
- 3. Fundamentals of Biostatistics- P. Hanmanth Rao and K. Janardhan, I K International Publishing House Pvt. Ltd.
- 4. Introduction to Biostatistics- Pranab Kumar Banerjee, S. Chand Company Ltd.
- 5. Elements of Biostatistics- Satguru Prasad, Rastogi Publications.

B.Sc. Semester – IV
Skill Enhancement Course (SEC)
BVS4P06: Clinical pathology
Practical 2 credits

Course outcomes: By the completion of the course the students will able to

- CO 1.** Develop proficiency in sample collection, handling, and processing techniques.
- CO 2.** Demonstrate competency in basic laboratory tests to assess cellular components and biochemical markers.
- CO 3.** Analyse and interpret common clinical test results, aiding in disease diagnosis.
- CO 4.** Acquire skills in urine, stool, and blood examination for diagnostic purposes.
- CO 5.** Apply knowledge of safety and ethical considerations in clinical pathology practice.

List of Experiments

1. Total leucocyte count.
2. Differential leucocyte count.
3. Total RBC count.
4. Total haemoglobin count.
5. Gram staining of bacteria.
6. Preparation of blood smear, staining methods (Wright's and Giemsa stains).
7. Erythrocyte sedimentation rate (ESR).
8. Chemical analysis of urine.
9. Physical analysis of urine.
10. Glucose estimation in blood.
11. Basic kidney function test (urea and creatinin).
12. Total cholesterol in blood by spectrophotometer.
13. Writing laboratory reports with clinical significance.

Practical Examination Scheme

Distribution of marks (For SEE)

	Total Marks 50
1. Perform Total leucocyte count/ Differential leucocyte count./ Total RBC count/ Total haemoglobin count.	10
2. Perform Gram staining of bacteria/Stain the blood smear by Wright's or Giemsa stains/ Erythrocyte sedimentation rate (ESR).	10
3. Perform Chemical analysis of urine/ Basic kidney function test (urea and creatinin).	10
4. Perform Physical analysis of urine/ Total cholesterol in blood by Spectrophotometer.	10
5. Estimate the blood glucose / write the laboratory reports of given TLC/ DLC/ Total RBC count/ Total haemoglobin count.	05
6. Viva-voce.	05

Reference Books

1. Laboratory Manual of Clinical Pathology and Hematology- Santosh Kumar Mondal.
2. Clinical pathology- A practical manual- Sabitri Sanyal, Aparna Bhattacharya.
3. Laboratory Manual of Biochemistry and Clinical Pathology- K.R. Mahadik, V.N. Jagtap, K.P. Sapre.
4. Practical Manual of Biochemistry and Clinical Pathology- G.D. Gupta, S. Sharma, M. Kaur.
5. Laboratory manual and review on clinical pathology- Jelalu Kemal.

B.Sc. Semester III
Minor 1: BZO1T01
Life and Diversity of Animals - Nonchordates (Protozoa to Annelida)
Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs):

- CO1. Students will be able to understand about early phyla viz., Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes and Annelida.
- CO 2. Students could be able to identify, classify and analyze different animals belonging to phylum Protozoa to Annelida on the basis of levels or grades of organization, symmetry, coelom etc. upto class.
- CO 3. Students will learn, analyze, describe a representative animal belonging to phylum Protozoa to Annelida
- CO 4. Students could elucidate and explain uniqueness of phylum Protozoa to Annelida and they could be able to demonstrate peculiar tissues, organs of animals belonging to these phyla.

Unit:I **7.5 Hrs.**

- 1.1 **Kingdom Protista, Phylum - Protozoa:** General characters of Protozoa.
- 1.2 **Paramecium:** Structure, locomotion and reproduction.
- 1.3 **Plasmodium:** Structure and life cycle.
- 1.4 **Parasitic Protozoans of Man :** *Entamoeba, Trypanosoma, Giardia and Leishmania* - Mode of infection, Damage and control.

Unit: II **7.5 Hrs.**

- 2.1 **Kingdom- Animalia:** Major phyla of Animalia, general characters and classification upto classes of Phylum Porifera.
- 2.2: **Sycon:** Structure, reproduction and development, Canal system in sponges.
- 2.3 **Coelenterata :** General characters and classification up to classes.
- 2.4 **Obelia :** Structure and life cycle, corals and coral reef formation.

Unit III **7.5 Hrs.**

- 3.1 **Platyhelminthes:** General characters and classification up to class.
- 3.2 **Taenia solium:** Structure and life cycle, parasitic adaptations in *Taenia solium*.
- 3.3 **Aschelminthes:** General characters and classification up to classes.
- 3.4 **Ascaris :** External morphology, reproductive system and life cycle.

Unit – IV **7.5 Hrs.**

- 4.1 **Annelida:** General characters and classification up to classes.
- 4.2 **Leech:** Morphology, digestive and urinogenital system.
- 4.3 **Annelidan larvae:** Trochophore larva and its significance.
- 4.4 Economic importance of Annelids: Harmful Annelids, Beneficial Annelids, Therapeutic value of Annelids.

BZO1P01: Practical- Life and Diversity of Animals- Nonchordates (Protozoa to Annelida)
(1 Credit)

1. Study of museum specimens (Classification of animals up to orders)

I. Protozoa (Slides) : *Paramecium, Euglena, Plasmodium vivax*

II. Porifera: *Sycon, Leucosolenia, Hyalonema, Euplectella, Spongilla*

- III. Coelenterata : *Obelia*, *Aurelia*, *Tubipora*, *Fungia*, *Adamsia*
 IV. Platyhelminthes : *Planaria*, *Fasciola*, *Taenia*
 V. Aschelminthes : *Ascaris*, *Drancunculus*, *Ancylostoma*, *Wuchereria*
 VI. Annelida : *Aphrodite*, *Nereis*, *Chaetopteurs*, *Tubifix*, *Hirudinaria*

2. Study of permanent slides

Enatmoeba, *Giardia*, Sponge gemmules, Sponge spicules, V.S. Sycon, T.S. Sycon, *Obelia* medusa, *Miracidium*, *Redia* and *Cercaria* larvae of *Fasciola*, T.S. male and female *Ascaris*, Scolex of *Taenia*, Mature and gravid proglottids of *Taenia solium*, T. S. of Leech through crop pockets, Trochophore larva

3. Anatomical observation (Demonstration only through You tube video and other ICT tools, models, and charts)

Digestive, nervous and reproductive system of Earthworm

4. Mounting

Spicules and gemmules of Sponge, *Obelia* colony, *Nereis* parapodia, Jaws of Leech, Nephridia of Leech.

Practical Examination Scheme

Distribution of Marks (For SEE)

Total Marks: 25

i. Identification and Comment on Spots (4 Museum specimens + 2 slides)	06
ii. Anatomical observation or Examination of pond water to identify invertebrates.	08
iii. Permanent stained preparation	04
iv. Submission of certified practical record	03
v. Submission of Slides	02
vi. Viva voce	02

Reference Books

1. Barnes R.D.(1980) – **Invertebrate Zoology**. Halt-Saunders international, 4th Edition, Philadelphia, USA, pp. 1089.
2. Borradaile L.A.and Potts F.A. (1935). **The Invertebrata; a manual for the use of students**, 2nd Edition. McMilan Publisher, New York, USA, pp. 746.
3. Nigam H. C. (2013). **Biology of Nonchordates**. Shoban Lal Nagin Chand, India, pp. 871.
4. Kotpal, Agrawal and Khetrapal (2012). **Modern Text Book of Zoology – Invertebrates**. Rastogi Publication, Meerut, India, pp.
5. Puranik P.G.and Thakur R.S. – **Invertebrate Zoology**
6. Majupuria T.C. – **Invertebrate Zoology**
7. Dhami and Dhami – **Invertebrate Zoology**
8. Parker and Hashwell, **Textbook of Zoology Vol. I (Invertebrates)** A.Z.T.B.S. Publishers and Distributors, New Delhi
9. Dr. S.S. Lal **Practical Zoology Invertebrates 9th edition**, Rastogi Publication Meerut
10. EJW Barrington– **Invertebrate Structure and Function** ELBS III Edition8
11. R.L. Kotpal – **Phylum Protozoa to Echinodermata (series)**, Rastogi and Publication, Meerut
12. Parker J. and Haswell W. – **Text Book of Zoology**, ELBS Edition
13. Vidyarthi – **Text Book of Zoology**, Agrasia Publishers, Agra
14. Jordan E.L. and Verma P.S. – **Chordate Zoology**, S. Chand and Co., New Delhi
15. Ayer E. – **Manual of Zoology**
16. M.D. Bhatia – **The Indian Zoological Memories – Leech**
17. Beni Prasad – **The Indian Zoological Memories – Pila**
18. P. K. Gupta – **Vermicomposting for Sustainable Agriculture**, Agrobios India Ltd
19. A manual of Practical Zoology Invertebrates – P. S. Verma

B.Sc. Semester III
Minor 2: BZO1T02
Environmental Biology
Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs):

- CO 1. Students will be able to describe and explain atmosphere, hydrosphere, lithosphere and energy resources.
- CO 2. Students could describe, elucidate different types and components of ecosystems. They could identify, describe and explain different biotic components and could explain and analyze their role in ecosystem.
- CO 3. Students will describe, explain and be aware about the significance and need of biodiversity conservation. They also understand, describe and explain legislations passed to conserve the biodiversity and acquainted themselves to nearby National Parks and Wildlife Sanctuaries.
- CO 3. They will elucidate and differentiate causes of different types and hazards of pollution.
- CO 4. Students will estimate the different physico-chemical parameters of water to analyze.

Unit-I

7.5 Hrs.

- 1.1 Atmosphere:** Major zones, importance, composition of air.
- 1.2 Hydrosphere:** Global distribution of water, Physico-chemical characteristics of water.
- 1.3 Lithosphere:** formation of soil, Causes of soil erosion.
- 1.4** Renewable and non-renewable energy sources.

Unit-II

7.5 Hrs.

- 2.1 Ecosystem-**Definition and Types- Forest, Grassland, Desert, Pond.
- 2.2** Food chain, food web.
- 2.3 Ecological pyramids-** Definitions, pyramids in pond, forest and parasitic food chain.
- 2.4** Energy flow in an ecosystem, Single channel, Y –shape and Universal model.

Unit-III

7.5 Hrs.

- 3.1** Biodiversity and its conservation, Biological Diversity Act, 2002.
- 3.2** Causes of reduction of biodiversity.
- 3.3** Salient features of Wildlife Protection Act, 1972, Zoological Survey of India: formation and role in animal conservation.
- 3.4** Hot spots of biodiversity in India, Introductory study of national parks and sanctuaries – Tadoba, Nagzira, Kanha.

Unit-IV

7.5 Hrs.

- 4.1 Air Pollution:** Sources, effect and control measures of air pollution, Acid rain, green house effect, ozone depletion and global warming.
- 4.2 Water Pollution:** Sources, effect and control measures of water pollution, effect of mercury.
- 4.3 Noise pollution:** Sources effect and control measures of noise pollution.
- 4.4** Biomagnification and Bioaccumulation.

BZO1P02: Practical- Environmental Biology (1 Credit)

1. Major Experiment:

- i. Estimation of dissolved oxygen (DO) of water.
- ii. Estimation of soil organic carbon by Walkley and Black (Rapid Titration) method.
- iii. Estimation of total hardness of water.

2. Minor experiment

- i. To demonstrate the functioning of Simple and Compound Microscope (Minor)
 - ii. Estimation of pH of water sample.
 - ii. Estimation of noise frequency by using dB meter.
 - iii. Quantitative analysis of plankton by Sedwick Rafter method.
 - iv. Estimation of free CO₂ of water .
3. Preparation of permanent stained preparation of zooplanktons
 4. Collection of photographs and identification of producers, primary consumers, secondary consumers, tertiary consumers, decomposers.
 5. Preparation of permanent stained preparation of zooplanktons.
 6. Study and collection of different types of zooplanktons.
 7. Study tour at nearby forest and to record faunal biodiversity of nearby forest.

Reference Books

1. Ashthana D.K.(2001). **Environmental Problem and Solution**, S. Chand Publication, pp. 434.
2. Agrawal K.C.(1987). **Environmental Biology**. Agrobios Publishers, pp. 439.
3. Agrawal K.C. (1996). **Biodiversity**. Agrobios Publishers, pp. 144.
4. Mukharjee B. (1980). **Environmental Biology**. Mcgraw Hill, pp. 640.
5. Arora S. (2008). **Fundamentals of Environmental Biology**. Kalyani Publisher, pp. 294.
6. Sharma P.D.(2012). **Ecology and Environmental Biology**. Rastogi Publication, pp. 640.
7. Verma P.S. and Agrawal V.K. (2000). **Environmental Biology**, S.Chand Publication, pp. 434.
8. Trivedi and Rao – **Air Pollution**
9. Chapman J.L. and Reiss M.J. (1998). **Ecology-Principles and Applications**, 2nd ed., Cambridge University Press, pp. 336.
10. Chatterjee B (2003). **Environmental Laws-Implementation Problems and Perspectives**. Deep and Deep Publications, India, pp. 304
11. Sharma P.D. (1997). **Environmental Biology**, Rastogi Publication, Meerut, pp. 416.
12. Trivedi R.K. (19976). **Handbook of Environmental Laws, Acts, Rules, Guidelines, Compliances and Standards**. Enviro Media.
13. Odum E.P. and Barret G,W, (2005). **Fundamentals of Ecology**, 5th edition. Thomson Brooks/ Cole , pp.598.
14. Smith R.L. (1996). **Ecology and Field Biology**, Harper Collins
15. Saxena D.N. – **Environmental Biology**, Studium Press (India)
16. Davis – **Behavioral Ecology**
17. Kumar U. and Asija M.J. (2000). **Biodiversity – Principle and Conservation**. Agrobios Publishers, pp. 302.
18. Rao M. and Rao H.V.N. (2017). **Air Pollution**, Mcgraw Hill, pp. 339.
19. Satyanarayan S., S. B. Zade S.B., S.R. Sitre S.R.and Meshram P.U. – **A Text Book of Environmental Studies**, Allied publisher (India)
20. Smitz R.J. (1996). **Introduction to Water Pollution**. Asian Books Private Limited, pp. 320
21. Subrahmanyam N.S. and. Sambamurthy A V.S.S (2000). **Ecology**. Narosa Publishing House, pp. 616.

B.Sc. Semester IV

Minor 3: BZO2T03

Life and Diversity of Animals – Non-Chordates (Arthropoda to Hemichordata)

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs):

- CO 1. Students will learn, identify, explain and analyze the taxonomic position of animals belonging to phylum Arthropoda to Hemichordata
- CO 2. They could describe, explain and analyze phylogeny to understand the course of evolution in animals from phylum Arthropoda to Hemichordata
- CO 3. They will be able to describe, explain and differentiate various morphological, anatomical structures and functions of animals of phyla from Arthropoda to Hemichordata.
- CO 4. Students will be able to understand, describe, explain and differentiate the larval forms and development of the invertebrates from phylum Arthropoda to Hemichordata
- CO 5. Students will be able to describe, explain and analyze the ecological and economic importance of invertebrates.
- CO 6. Students will understand, be able to describe, explain and analyze the ecological role of invertebrates in the biodiversity.

UNIT: I

7.5 Hrs

- 1.1. Arthropoda:** General characters of the phylum and classification up to classes with suitable examples.
- 1.2. Cockroach:** Digestive system, Male and Female reproductive system.
- 1.3. Insects as Vectors :** Mosquito, Housefly, Tse-Tse fly.
- 1.4. Study of crustacean larvae:** Nauplius, Zoea and Megalopa.

UNIT: II

7.5 Hrs

- 2.1 Mollusca:** General characters and classification up to classes.
- 2.2 Pila:** Respiratory system and Mechanism of Aquatic and Pulmonary respiration.
- 2.3 Economic importance of Mollusca:** Edible oyster farming, pearl forming mollusc, types of pearl culture.
- 2.4 Molluscan larva:** Glochidium and Veliger.

UNIT: III

7.5 Hrs

- 3.1 Echinodermata:** General characters and classification up to classes.
- 3.2 Asterias:** External morphology, Straight and Crossed type of Pedicellariae.
- 3.3** Water vascular system and locomotion in *Asterias*.
- 3.4** Echinoderm larva: Bipinnaria and Auricularia.

UNIT: IV

7.5 Hrs

- 4.1 Hemichordata:** General characters and Phylogeny.
- 4.2 Balanoglossus:** External features and digestive system.
- 4.3** Pre-Larval Development in Balanoglossus, Tornaria larva.
- 4.4** Affinities of Balanoglossus with Annelida, Echinodermata and Chordata.

BZO2P03: Practical- Life and Diversity of Animals – Non-Chordates (Arthropoda to Hemichordata) (1 Credit)

1. Study of museum specimens (Classification of animals up to orders)

- I. Arthropoda : Crab, Prawn, Scolopendra, Julus, Dragonfly, Moth, Limulus

- II. Mollusca : Chiton, Dentalium, Pila, Mytilus, Sepia, Octopus
- III. Echinodermata : Asterias, Ophiothrix, Holothuria, Antedon, Echinus
- IV. Hemichordata : Balanoglossus, Saccoglossus
- 2. Study of permanent slides-** Nauplius, Zoea and Megalopa larva of Arthropoda, Glochidium larva, Bipinnaria larva, T.S. Balanoglossus through branchiogenital region, Tornaria larva
- 3. Anatomical observation** (Demonstration Only -Through You Tube Video and other ICT tools, Models, Charts) –
 - I. Digestive system of Cockroach
 - II. Male and Female Reproductive system of Cockroach
 - III. Water vascular system in *Asterias*.
- 4. Mounting (Any two)** - I. Crustacean larvae and planktons
 - II. Mouth Parts of Insects – Cockroach/Mosquitoes
 - III. Gill lamella of Pila
- 5. Collection of photograph of insect vectors.**
- 6. Examination of pond water to identify aquatic Arthropods and Molluscs.**

Practical Examination Scheme

Distribution of Marks (For SEE)	Total Marks: 25
i Identification and Comment on Spots (4 Museum specimens + 2 slides)	06
ii Anatomical observation or Examination of pond water to identify invertebrates.	08
iii Permanent stained preparation	04
iv Submission of certified practical record	03
v. Submission of Slides	02
vi. Viva voce	02

Reference Books

1. Barnes – **Invertebrate Zoology (Holt-Saunders international)** Philadelphia, USA
2. Barradaile L.A. and Potts F.A. – **The Invertebrate**
3. Nigam – **Biology of Nonchordates**
4. Kotpal, Agrawal & Khetrapal – **Modern Text Book of Zoology - Invertebrates**, Rastogi Publication, Meerut
5. Puranik P.G. and Thakur R.S. – **Invertebrate Zoology**
6. Majumuria T.C. – **Invertebrate Zoology**
7. Dhami and Dhami – **Invertebrate Zoology**
8. Parker and Hashwell, **Textbook of Zoology Vol. I (Invertebrates)** A.Z.T.B.S. Publishers and Distributors, New Delhi
9. Dr. S.S. Lal **Practical Zoology Invertebrates**. 9th edition, Rastogi Publication Meerut
10. E.J.W. Barrington– **Invertebrate Structure and Function**. 8th Edition, ELBS III
11. R.L. Kotpal – **Phylum Protozoa to Echinodermata**, Rastogi and Publication, Meerut
12. Parker J. and Haswell W. – **Text Book of Zoology**, ELBS Edition
13. Vidyarthi – **Text Book of Zoology**, Agrasia Publishers, Agra
14. Jordan E.L. and Verma P.S. – **Chordate Zoology**, S. Chand and Co., New Delhi
15. Ayer E. – **Manual of Zoology**
16. M.D. Bhatia – **The Indian Zoological Memories – Leech**
17. Beni Prasad – **The Indian Zoological Memories – Pila**
18. P. K. Gupta – **Vermicomposting for Sustainable Agriculture**, Agrobios India Ltd
19. A manual of Practical Zoology Invertebrates – P. S. Verma

b.Sc. Semester IV

Minor 4: BZO2T04

Cell Biology

Theory- 2 Credits + Practical - 1 Credit

Course Outcomes (COs):

- CO1. Students will able to describe, sketch, analyze, and explain the structure and function of the cell organelles.
- CO2. Students could describe, sketch, analyze, and explain the structure and function of nucleus and chromatin structure, its location.
- CO 3. Students will able to describe, sketch, analyze, and explain the basic principle of life. They could also demonstrate and explain how a cell divides leading to the growth of an organism.
- CO 4. Students could describe, sketch, analyze, and explain how a cell communicates with its neighbouring cells.
- CO 5. Students will able to describe, sketch, analyze, and explain the abnormality in structural and functional aspects of cells.
- CO 6. Students will able handle and use microscopes and oculometer to elucidate and measure and explain the minor details of tissues.
- CO 7. Students will able to demonstrate osmosis. They could also demonstrate and explain mitochondria, salivary gland chromosome and Barr body in cells.

UNIT: I

7.5 Hrs.

- 1.1** Ultra-structure of Plasma membrane and it's chemical composition
- 1.2 Endomembrane system:** Protein sorting, transport, exocytosis, endocytosis
- 1.3 Cell-cell interaction:** Cell adhesion molecules, cellular junction
- 1.4 Golgi Complex:** Structure and functions.

UNIT 2

7.5 Hrs.

- 2.1 Cytoskeleton:** Microtubules, Microfilaments, intermediate filaments.
- 2.2 Mitochondria:** Structure and Oxidative phosphorylation, ETS.
- 2.3 Peroxisome:** Structure and functions.
- 2.4 Ribosome:** Structure, types, Lake's model and functions.

UNIT 3

7.5 Hrs.

- 3.1 Lysosome:** Structure, polymorphism and functions
- 3.2** Structure and function of Nucleus and Nuclear membrane
- 3.3** Chemical Composition and base composition of DNA and RNA
- 3.4 Chromatin Modelling:** Supercoiling, Chromatin organization, structure of chromosome

UNIT 4

7.5 Hrs.

- 4.1** Cell cycle and its regulation, Apoptosis
- 4.2 Cell Division:** Mitosis and Meiosis
- 4.3 Signal transduction:** Intracellular signalling, cell surface receptors, G-protein coupled receptors
- 4.4** Cellular aging and cell death

BZO2P04: Practical- Cell Biology (1 Credit)

1. Major Experiment

- a. Study of Osmosis in human RBCs (Hypertonic, hypotonic and isotonic).
- b. Demonstration of Mitotic cell division in *Allium cepa*.
- c. Demonstration of Salivary gland chromosome in Mosquito/ *Chironomous* larvae.
- d. Demonstration of Barr body in blood smear.

2. Minor Experiment

- a. Use of Ocular micrometer and measurement of Micro objects.
- b. Demonstration of Meiotic cell division in *Tradescantia* buds or Grasshopper Testis (Virtual/Pictorial).
- c. Demonstration of mitochondria in buccal epithelium by Janus green B method.

3. Reading/Preparation/Presentation a report on Indian Scientist who contributed in the field of Cell biology/Molecular Biology (Dr. Hargovind Khurana, Dr. Lalji Singh, Dr/ Shantiswaroop Bhatnagar, Dr. Arunkumar Yadav etc.)

4. Preparation of photographic cards on various cell organelles.

Reference Books

1. Powar C.B. (1991). **Cell Biology**. Himalaya Publication, New Delhi, pp. 782.
2. Dr. S.P. Singh, Dr. B.S. Tomar (2007). **Cell Biology**. 9th revised edition, Rastogi Publication, Meerut
3. Gupta P.K. (2018). **Cell and Molecular Biology**. Rastogi Publication, Meerut, pp. 942.
4. Veer Bala Rastogi. **Introduction to Cell Biology**, Rastogi Publication, Meerut
5. Gerald Karp (2007). **Cell and Molecular Biology-Concepts and Experiments**, John Wiley and Sons, pp. 843.
6. De Robertis, E. D. P., Nowinski, W. W., Saez, F. A. (1965). **Cell Biology**, Saunders, pp. 446.
7. Verma P.S. and Agrawal V.K. **Concepts of Cell Biology**
8. Dowben R.M. (1971). **Cell Biology**. Harper and Row Limited, pp. 570.
9. Witt – **Biology of Cell**
10. Ambrose E.J. and Easty D.M. (1970). **Cell Biology**. Thomas Nelson and Sons Ltd, pp.500.