

Department of ZOOLOGY

School of Science

Curriculum Bachelor of Science Programme: Zoology



Uttarakhand Open University  
Teenpani Bypass, University Road, Behind T.P Nagar  
Haldwani - 263139, Nainital  
Uttarakhand

## PROGRAMME STRUCTURE: BACHELOR OF SCIENCE

**Name of Programme:** BACHELOR OF SCIENCE

**Programme Code:** BSC-14

**Programme Mode:** Annual

**Admission Cycle :** Once every Year in July

**Eligibility:** Senior Secondary (10+2) in science from any recognized Board

**Duration** Min: 3 Years; Max: 6 Years

**Self Learning Material (SLM):** English (Hindi SLM will be developed by translating the English SLM by maintain technical terminology of English only)

**Total Credit:** 108

**Objectives:** To provide an opportunity for science education to the door steps of aspirants and for skill development to enhance employability or entrepreneurship.

PROGRAMME STRUCTURE		
NAME OF SUBJECT	CODE	TOTAL CREDITS
<b>A. Optional subjects (Three subjects per year with 12 credit each)</b>		
1. Botany	BO	12
2. Chemistry	CH	12
3. Geography	GE	12
4. Mathematics	MT	12
5. Physics	PH	12
6. Zoology	ZO	12
Total programme will be of 3 years. A student shall have to take a total of 36 credits out of three subjects in one year (12 credits per subject). The courses in Mathematics and Geography discipline will be of 4 credits whereas in other subjects each course will be of 3 credits.		

The subjects combinations may be given with **Zoology** are as follows:

Subject A	Subject B	Subject C
Zoology	Botany	Chemistry
Zoology	Botany	Geography

# Programme Structure (Year wise)

## B.Sc. (Zoology Subject)

### FIRST YEAR

S.N.	Course Name	Course Code	Marks			Credits	Minimum Counseling hours
			Th.	Ass.	Total		
1.	Non-Chordata	BSC ZO101	35	15	50	03	09
2.	Cell and Molecular Biology	BSC ZO102	35	15	50	03	09
3.	Genetics, Taxonomy and Evolution	BSC ZO103	35	15	50	03	09
4.	Laboratory Course I	BSC ZO104			50	03	09

### SECOND YEAR

S.N.	Course Name	Course Code	Marks			Credits	Minimum Counseling hours
			Th.	Ass.	Total		
5.	Chordata	BSC ZO201	35	15	50	03	09
6.	Environmental Biology & Animal Behavior	BSC ZO202	35	15	50	03	09
7.	Developmental Biology and Economic Zoology	BSC ZO203	35	15	50	03	09
8.	Laboratory Course II	BSC ZO204			50	03	09

### THIRD YEAR

S.N.	Course Name	Course Code	Marks			Credits	Minimum Counseling hours
			Th.	Ass.	Total		
9.	Physiology and Bio-Chemistry	BSC ZO301	35	15	50	03	09
10.	Microbiology, Immunology and Toxicology	BSC ZO302	35	15	50	03	09
11.	Biostatistics and Instrumentation techniques	BSC ZO303	35	15	50	03	09
12.	Laboratory Course III	BSC ZO304			50	03	09

## B.Sc. I Year (Zoology)

**Course 1: Non-Chordata**

**Course Code-(BSCZO101)**

**Credit: 3**

### Objective:

1. To comprehend the systematic position, functional morphology, mode of life and biodiversity of invertebrates
2. To study their economic importance, affinities and adaptations.
3. To study the parasitic forms of various invertebrate groups and their effect on human and animals.
4. Understand the general features of animal life cycles and forms of reproduction.
5. Describe the general features used to classify animal groups such as type of symmetry, number of tissue layers, body cavities, segmentation, cephalization and distinctive larval forms.

### Syllabus

General characters Classification up to order. Study of Paramecium with particular reference to locomotion, nutrition, osmoregulation and reproduction. Germ layers, diploblastics and triploblastics organization. Theories on the origin of Metazoans. General characters and Classification up to order level *Sycon* with special reference to structure, reproduction and development. Canal systems, affinities and economic importance of Porifera. General characters and Classification up to order level. Aurelia with special reference to structure, reproduction, development and polymorphism. A brief account of corals and coral reefs and their importance. General characters and Classification up to order level. Study of *Fasciola* with reference to structure, reproduction and parasitic adaptations. General characters and Classification up to order level. Study of *Ascaris* with special reference to structure, reproduction and development. General characters and Classification up to order level. *Nereis* with special reference to structure, reproduction and development. Metamerism and Parasitic adaptations in *Hirundinaria*. General characters and Classification up to order level. *Palaemon* with special reference to structure, reproduction and development. Types of mouth parts in insects. Social insects and their economic importance. General characters and Classification up to order level. Pila with special reference to structure, reproduction and development. General characters and Classification up to order level. Asterias with special reference to structure, locomotion, mode of feeding and reproduction.

### UNIT SCHEDULE

#### Block I: Lower Non chordate

Unit 1: Phylum Protozoa

Unit 2: Metazoa

Unit 3: Phylum Porifera

Unit 4: Phylum Coelenterata

Unit 5: Phylum Platyhelminthes

Unit 6: Phylum Nematelminthes

Unit 7: Phylum Annelida

**Block II: Higher Non Chordata**

Unit 8: Phylum Arthropoda

Unit 9: Phylum Mollusca

Unit 10: Phylum Echinodermata

## Course 1: Non- Chordata (BSCZO101)

### UNIT WISE CONTENTS (BSCZO101)

#### Block I: Lower Non chordate

##### Unit 1: Phylum Protozoa

General characters Classification up to order. Study of *Paramecium* with particular reference to locomotion, nutrition, osmoregulation and reproduction.

##### Unit 2: Metazoa

Germ layers, diploblastics and triploblastics organization.

##### Unit 3: Phylum Porifera

General characters and Classification up to order level. *Sycon* with special reference to structure, reproduction and development. Canal systems and affinities.

##### Unit 4: Phylum Coelentrata

General characters and Classification up to order level. *Aurelia* with special reference to structure, reproduction, development and polymorphism. A brief account of corals and coral reefs and their importance.

##### Unit 5: Phylum Platyhelminthes

General characters and Classification up to order level. Study of *Fasciola* with reference to structure, reproduction and parasitic adaptations.

##### Unit 6: Phylum Nematelminthes

General characters and Classification up to order level. Study of *Ascaris* with special reference to structure, reproduction and development.

##### Unit 7: Phylum Annelida

General characters and Classification up to order level. *Nereis* with special reference to structure, reproduction and development. Metamerism and Parasitic adaptations in *Hirudinaria*.

#### Block II: Higher Non Chordata

##### Unit 8: Phylum Arthropoda

General characters and Classification up to order level. *Palaemon* with special reference to structure, reproduction and development. **Zoological importance of *Peripatus*** (please separate it). Types of mouth parts in insects. Social insects and their economic importance.

##### Unit 9: Phylum Mollusca

General characters and Classification up to order level. *Pila* with special reference to structure, reproduction and development.

## Unit 10: Phylum Echinodermata

General characters and Classification up to order level. *Asterias* with special reference to structure, locomotion, mode of feeding and reproduction.

### Suggested Readings:

1. Hickman C.P. Jr., Hickman, F.M. and Roberts, L.S.: Integrated Principles of Zoology, Mosby College Publication. East. Louis.
2. Ayyar, E.K. and Ananthakrishnan. I.N.: Manual of Zoology, Vol.1 (Invertebrata), Parts I & II S. Viswanatham (Printers and Publishers) Pvt. Ltd., Madras.
3. Jordan, E.I., and Verma, P.S.: Invertebrate Zoology, S. Chand & Co. Ltd., Ram Nagar, New Delhi.
4. Parker and Haswell : Text Book of Zoology, Vol.1, (Invertebrata), A.Z.T.B.S. Publishers and Distributors, New Delhi-110051.
5. Kotpal, Agarwal & Khetrpal : Modern text book of Zoology : Invertebrate, Rastogi Publications.
6. Nigam, H.C. : Biology of Non-Chordates, Shobam Lal Nagin Chand & Co. Rastogi, V.B. : Invertebrate Zoology, Kedarnath Ramnath
7. Jordon and Verma: Invertebrate Zoology (1995, S. Chand)
8. Kotpal. R.L. Modern Text Book of Zoology: Invertebrates. Rastogi Publications, Merruit.

## **Course II: Cell and Molecular Biology (BSCZO102)**

### **Course Objectives:**

1. To understand the structures and purposes of basic components of prokaryotic and eukaryotic cells, especially macromolecules, membranes, and organelles
2. To learn the cytological techniques, the structure and functions of various cellular components.
3. To understand how these cellular components are used to generate and utilize energy inside the cells and process of cell division.
4. To understand the fine structure of genetic materials and regulation of their action.
5. To know the chromosomal basis of genetic disorder, development and differentiation. Also, to know the importance of population genetics and nuances of genetic engineering and applied genetics.
6. Hereditary process, Chromosomal organization and importance of sex linked inheritance for man and other animals

### **Syllabus**

History and origin. Prokaryotic and Eukaryotic cell. Difference between Prokaryotic and Eukaryotic cell. History, Ultra structure, and chemical composition of plasma membrane (Lamellar-models, Micellar model and fluid mosaic model). Functions of plasma membrane. History and structure, biogenesis and functions of mitochondria (Respiratory chain complex and Electron transport mechanism). History, structure, functions and importance Endoplasmic reticulum, Ribosome and Golgi bodies. History, structure, functions and importance of Lysosome, centriole and microtubules. History, structure, function and importance of Nucleus. History, types & functions of chromosomes. Giant chromosomes, Polytene chromosome and Lampbrush chromosome. Mitosis (cell cycle stages, cytokinesis) Meiosis (reproductive cycle stages, synaptonemal complex, recombination nodules) and comparison between meiosis and mitosis. Structure, functions and type of DNA, Watson and Crick's structural model of DNA, chemical composition of DNA, replication of DNA and recombinant DNA. Structure of RNA (primary, secondary and tertiary structure) and types of RNA (transfer RNA, messenger RNA, ribosomal RNA). Biosynthesis of m-RNA, t-RNA. Function and importance of RNA. Protein Synthesis and regulation: Protein Synthesis, mechanism (initiation, elongation and termination) of protein synthesis. Gene regulation (Operon hypothesis: regulator gene, promoter gene, operator gene, structural gene, repressor gene, co-repressor gene and inducer gene), regulation at transcription, regulation by gene arrangement and reversible phosphorylation, types of control mechanisms, regulation of gene activity in eukaryotes. Genetic Code: Properties of genetic code, codon and anti codon. The Wobble Hypothesis, Mutation and the triplet code.



## **UNIT SCHEDULE**

### **Block I: Cell biology or Cytology**

**Unit 1:** Cell type

**Unit 2:** Plasma membrane

**Unit 3:** Mitochondria

**Unit 4:** Endoplasmic reticulum, Ribosome, Golgi bodies

**Unit 5:** Lysosome, centriole, microtubules

**Unit 6:** Nucleus

**Unit 7:** Chromosomes

**Unit 8:** Cell division

### **Block II: Molecular Biology**

**Unit 9:** Structure and type of DNA and replication

**Unit 10:** Structure of RNA and transcription

**Unit 11:** Protein Synthesis and regulation

**Unit 12:** Genetic Code

### **Suggested Readings:**

1. Lodish: Molecular Cell Biology (Freeman).
2. Rastogi, V.B.: Introductory Cytology, Kedarnath Ramnath.
3. Verma, P.S. & Agarwal, V.K.: Cytology, S. Chand & Col Ltd.
4. Hartl & Jones: Essential Genetics: A Genomic Perspective (2002, Jones & Bartlett).
5. Russell: Genetics (2002, Benjamin Cummings).
6. Snustad & Simmons: Principles of Genetics (2006, John Wiley).
7. Lewin: Genes IX (2008, Jones & Bartlett).

## **Cell and Molecular Biology (BSCZO102)**

### **UNIT WISE CONTENTS**

#### **Block I (Cell biology or Cytology)**

##### **Unit 1:** Cell type

History and origin. Prokaryotic and Eukaryotic cell. Difference between Prokaryotic and Eukaryotic cell.

##### **Unit 2:** Plasma membrane

History, Ultra structure, and chemical composition of plasma membrane (Lamellar-models, micellar models (Micellar model) and fluid mosaic model). Functions of plasma membrane

##### **Unit 3:** Mitochondria

History and structure of mitochondria, biogenesis and functions of mitochondria (Respiratory chain complex and Electron transport mechanism).

##### **Unit 4:** Endoplasmic reticulum, Ribosome, Golgi bodies

History, structure, functions and importance

##### **Unit 5:** Lysosome, centriole, microtubules

History, structure, functions and importance

##### **Unit 6:** Nucleus

History, structure, functions and importance

##### **Unit 7:** Chromosomes

History, types and functions of chromosomes. Giant chromosomes, Polytene chromosome and Lampbrush chromosome.

##### **Unit 8:** Cell division

Mitosis (cell cycle stages, cytokinesis) Meiosis (reproductive cycle stages, synaptonemal complex, recombination nodules). Comparison between meiosis and mitosis.

#### **Block II: Molecular Biology**

##### **Unit 9:** Structure and type of DNA

Structure, functions and type of DNA, Watson and Crick's structural model of DNA, chemical composition of DNA, replication of DNA and recombinant DNA.

**Unit 10: Structure of RNA**

Structure of RNA (primary, secondary and tertiary structure) and types of RNA (transfer RNA, messenger RNA, ribosomal RNA). Biosynthesis of m-RNA, t-RNA. Function and importance of RNA.

**Unit 11: Protein Synthesis and regulation**

Protein Synthesis, mechanism (initiation, elongation and termination) of protein synthesis. Gene regulation (Operon hypothesis: regulator gene, promoter gene, operator gene, structural gene, repressor gene, co-repressor gene and inducer gene), regulation at transcription, regulation by gene arrangement and reversible phosphorylation, types of control mechanisms, regulation of gene activity in eukaryotes.

**Unit 12: Genetic Code**

Properties of genetic code, codons and anti codon. The Wobble Hypothesis, Mutation and the triplet code.

**Suggested Readings:**

1. Lewis. C.D. and Lewin, R.: Biology of Gene, Me Graw Hill, Toppan Co. Ltd.
2. Gunther S. Stent: Molecular Genetics, Macmillan Publishing Co. Inc.
3. Goodenough, V.: Genetics, New York Holt, Rinehart and Winston.
4. Gardner: Principles of Genetics, Wiley Eastern Pvt. Ltd.
5. Winchester Genetics, Oxford IBH Publications.
6. Stickberger Genetics, Macmillan Publications.
7. Pai, A.C.: Foundations of Genetics, Mc Graw Hill Publications.
8. Gupta, P.K.: Cytology, Genetics & Evolution, Rastogi Publications.
9. Verma. P.S. and Agarwal, V.K.: Genetics, S. Chand & Co. Ltd.

### **Course 3: Genetics, Taxonomy and Evolution (BSCZO103)**

#### **Course Objectives:**

1. To develop understanding on Systematic and the evolutionary understanding of biological phenomena.
2. To understand the International Code of Zoological Nomenclature, Its operative principals, Zoological nomenclature and formation of scientific names of various taxa.
3. To understand the molecular basis of cell structure, DNA structure and functions and types of genetic molecules and their functions in different cells.
4. Chemical structure and functioning of different biological molecules: carbohydrates, lipids, proteins, and nucleic acids in physiological property of animals.
5. Explain the basic pathways and mechanisms in biological energy transduction from oxidation of metabolites to synthesis of ATP.
6. Understand the Causes, Processes, and Consequences of Evolution.
7. Understand the Principal Mechanisms of Evolution through the process of macro, micro and mega evolutionary process.

#### **Syllabus**

Elements of heredity and variation, Mendel's principles of heredity, linkage (Coupling and repulsion), crossing-over (mechanism, theories and importance). Chromosomal mapping (Three point cross). Chromosomal Mutation: Classification, Translocation, Inversion, Deletion, Duplication, Euploidy, Aneuploidy and Polysomy. Genetic interaction: Gene structure and function. Methods to study the human inheritance. Recessive inherited disorder, dominant inherited disorder, inborn errors of metabolism, sickle cell anaemia and other genetic disorders. Taxonomy and Systematics: Historical resume of systematics. Introduction to taxonomy and its relationship with systematics. Importance and applications of biosystematics. International Code of Zoological Nomenclature, Binomial, Trinomial components of classification and formation of scientific names of various taxa. Taxonomic characters: Morphological, Embryological, Cytogenetical, Biochemical and Numerical. Components of classification and Linnaean hierarchy. Concept of species: Species category, different species concept, Sub species and other infra species. Nature, types and potential modes of speciation. Special creation theory, theories of spontaneous generation, cosmozoic theory, theory of chemical evolution and spontaneous origin of life at molecular level. Concept of organic evolution: evidences from paleontology (types of fossils and determination of age of rocks and fossils), taxonomy, comparative anatomy, comparative embryology, physiology and biochemistry and cytology. Theories of organic evolution: Lamarckism, Darwinism, Mutation theory and modern synthetic theory. Modern evolutionary Concept and details of micro, macro and mega evolution. Major Zoo-geographical realms and distribution patterns of animals in different zoogeographical realms. Biogeographical regions in India.

## **UNIT SCHEDULE**

### **Block I: Genetics**

**Unit 1:** Mendelism and Elements of heredity

**Unit 2:** Chromosomal Mutation

**Unit 3:** Genetic interaction

**Unit 4:** Human genetics

### **Block II: Taxonomic concept**

**Unit 5:** Taxonomy and Systematics

**Unit 6:** Zoological Nomenclature

**Unit 7:** Kinds of taxonomic characters and classification

**Unit 8:** Concepts of Species

### **Block III. Evolution**

**Unit 9:** Origin of life

**Unit 10:** Concept of organic evolution

**Unit 11:** Theory of organic evolution

**Unit 12:** Evolutionary concept

**Unit 13:** Zoogeographical realm

## **Genetics, Taxonomy and Evolution (BSCZO103)**

### **UNIT WISE CONTENTS**

#### **Block I: Genetics**

##### **Unit 1:** Mendelism and Elements of heredity

Elements of heredity and variation, Mendel's principles of heredity, linkage (Coupling and repulsion), crossing-over (mechanism, theories and importance). Chromosomal mapping (Three point cross).

##### **Unit 2:** Chromosomal Mutation

Classification, Translocation, Inversion, Deletion, Duplication, Euploidy, Aneuploidy and Polysomy

##### **Unit 3:** Genetic interaction

Gene structure and function

##### **Unit 4:** Human genetics

Recessive inherited disorder, dominant inherited disorder, inborn errors

#### **Block II: Taxonomic concept**

##### **Unit 5:** Taxonomy and Systematic

Introduction to taxonomy and its relationship with systematic. Importance and applications of biosystematics.

##### **Unit 6:** Zoological Nomenclature

International Code of Zoological Nomenclature, Binomical and Trinomial components of classification.

##### **Unit 7:** Kinds of taxonomic characters and classification

Taxonomic characters: Morphological, Embryological, Cytogenetically, Biochemical and Numerical. Components of classification and Linnaean hierarchy.

##### **Unit 8:** Concepts of Species

Concept of species and speciation and potential modes of speciation.

### **Block III. Evolution**

#### **Unit 9:** Origin of life

Special creation theory, theories of spontaneous generation, cosmozoic theory, theory of chemical evolution and spontaneous origin of life at molecular level

#### **Unit 10:** Concept of organic evolution

Concept of organic evolution: evidences from paleontology (types of fossils and determination of age of rocks and fossils), taxonomy, comparative anatomy, comparative embryology, physiology and biochemistry and cytology.

#### **Unit 11:** Theory of organic evolution

Theories of organic evolution: Lamarckism, Darwinism, Mutation theory and modern synthetic theory

#### **Unit 12:** Evolutionary concept

Modern evolutionary Concept and details of micro, macro and mega evolution

#### **Unit 13:** Zoogeographical realms

Major Zoo-geographical realms and distribution patterns of animals in different zoogeographical realms. Biogeographically regions in India.

### **Suggested Readings:**

1. Alberts, Bray, Lewis, Raff, Roberts & Watson: Molecular Biology of the Cell (Garland).
2. Alberts: Molecular Biology of the Cell (Garland).
3. De Robertis & De Robertis: Cell and Molecular Biology.
4. Gupta, P.K. : Cycology, Genetics & Evolution Rastogi Publications.
5. Brooker: Genetics : Analysis and Principles (1999, Addison-Wesley,)
6. Gardner *et al*: Principles of Genetics (1991, John Wiley)
7. Snustad & Simmons: Principles of Genetics (2006, John Wiley).
8. Moody: Introduction to Evolution (1978, Kalyani).
9. Savage: Evolution (1963, Holt, Reinhart and Winston)
10. Rastogi: Organic Evolution (1988, Kedarnath & Ramnath)
11. Strickberger: Evolution (2004, Jones & Bartlett)

## **Course IV: Laboratory Course (Practical Zoology)**

### **Objectives:**

1. Describe and explain the basic principles of animal classification, form and function among Invertebrate phyla.
2. Identify and classify the main groups of invertebrates through the study of available museum specimens/model/posters.
3. Classification of animals: basic structure and functional features of the Protozoa, Porifera, Radiata, Acoelomata, Pseudo-coelomata. Annelida, Arthropoda, Mollusca and Echinodermata.
4. To study the microscopic animals and larva of different invertebrate phyla through the permanent slide/ whole mount observation.
5. To study the cytological experiments i.e. cell division stages
6. To develop practical understanding on Mendelian and non- Mendelian hereditary experiments.

### **Syllabus:**

Museum Specimens: study of Porifera, Coelentrata, Ctenophora, Platyhelminthes, Nematelminthes, Annelida, Arthropoda, Mollusca and Echinodermata. Dissection study including general anatomy of leech, *Pila*, *Unio*, Prawn and cockroach. Study of permanent slides/ museum specimens/ models belonging to following phyla: Protozoa, Annelida, Arthropoda, Mollusca and Echinodermata. Larval stages study of different non chordate groups using whole mount slides: Annelida, Mollusca, Arthropoda and Echinodermata. Permanent preparation of obelia colony: Ovary, pharyngeal and septal nephidium earthworm, parapodia of Nereis and Heteronereis; gill, radula and osphradium of *Pila*, salivary glands, mouth parts and trachea of cockroach, gill lamina of *Unio*, staocyst and hastate plate of prawn. Study of mitosis and meiosis using available material. Experimentation on Mendelian and non Mendelian inheritance.

## **UNIT SCHEDULE**

### **Block I: Museum Specimen study**

**Unit1:** Protozoa (study of Permanent slides)

**Unit2:** Porifera (Study of permanent slides and Museum specimens)

**Unit3:** Coelentrata (Study of museum specimens and permanent slides)

**Unit4:** Platyhelminthes

**Unit5:** Nematoda

**Unit6:** Annelida (Study of museum specimens, permanent slide and slide preparation and study)

**Unit7:** Arthropoda (Museum specimens, whole mount and slide preparation)

**Unit8:** Mollusca (Museum specimens, whole mount/slides and slide preparation)

**Unit9:** Echinodermata (Museum specimens, whole mount/slides and slide preparation)

### **Block II: Experimentation**

**Unit10:** Dissection

**Unit11:** Permanent slide preparation

**Unit12:** Cytological study

**Unit13:** Genetics experiment



## UNIT WISE CONTENTS (BSCZO104)

Identification, systematic position up to order and general study of the following animal forms, microscopic slides / museum specimens:

- Unit 1:** Protozoa: *Amoeba*, *Paramecium*, *Euglena*, *Ceratium* and *Noctiluca*. *Plasmodium*, Monocystis, *Trypanosoma*, *Leishmania*, *Entamoeba* and *Giardia*
- Unit 2:** Porifera: *Leucosolenia*, *Grantia*, *Scypha*, *Hyalonema*, *Euplectella*, *Spongilla* and *Euspongia*. L. S. and T. S. of *Scypha* / *Grantia*
- Unit 3:** Coelenterata: Medusa of *Obelia*, larval stages of *Aurelia*, *Physalia*, *Porpita*, *Vellela*, *Tubipora*, *Millepora*, *Aurelia*, *Gorgonium*, *Pennatula*, *Alcyonium*, *Adamsia*
- Unit 4:** Platyhelminthes: *Dugesia*, *Fasciola* and *Taenia*. Transverse sections of *Fasciola* and *Taenia*, mature and gravid proglottids of *Taenia*, developmental stages of *Fasciola* and *Taenia*
- Unit 5:** Nematoda: *Ascaris*, *Ancylostoma*, *Dracunculus*, *Wuchereria*, *Trichinella*, *Schistosoma* and *Enterobius*
- Unit 6:** Annelida: *Nereis*, *Heteronereis*, *Aphrodite*, *Arenicola*, *Metaphire*, *Pontobdella*, and *Hirudinaria*. Transverse sections of *Nereis* and *Hirudinaria*, Trochophore larva of *Nereis*, Parapodium of *Nereis* and *Heteronereis*
- Unit 7:** Arthropoda : *Limulus*, Spider, *Palamnaeus*, *Apis*, *Lepas*, *Balanus*, *Sacculina*, *Palaemon*, Lobster, *Eupagurus*, Crab, *Lepisma*, *Odontotermes*, *Pediculus*, *Schistocerca*, *Papilio*, *Bombyx*, *Xenopsylla*, *Julus* and *Scolopendra*. Crustacean larvae (*Nauplius*, *Zoea*, *Megalopa* and *Mysis*), mosquito larva & pupa. *Sacculina*, Lice, flea, bedbug, tick and mites
- Unit 8:** Mollusca: *Chiton*, *Dentalium*, *Sepia*, *Patella*, *Pila*, *Turbinella*, *Aplysia*, Slug, Snail, *Mytilus*, Octopus. Transverse sections of Lamellidens and Glochidium larva
- Unit 9:** Echinodermata: *Pentaceros*, *Asterias*, *Ophiothrix*, *Echinus*, *Holothuria* and *Antedon*. Pedicellariae of Star fish
- Unit 10:** Study of living animals: *Amoeba*, *Paramecium*, *Euglena*, *Hydra* and rectal ciliates
- Unit 11:** Permanent slide preparation/ Dissections
- Permanent preparations / Minor dissections of the following:
- Protozoa: *Paramecium*
  - Porifera: Sponge spicules and gemmules.
  - Coelenterata: *Obelia* colony, *Obelia* medusa.
  - Arthropoda: Mouth parts of honey bee, butterfly, cockroach and grasshopper.
- Unit 12:** Cytological study
- a. Study of mitosis and meiosis using available material.

- b. Study of permanent slides showing stages of cell division, giant chromosome, mitochondria, Golgi body etc

**Unit 13:** Genetics experiment

Experimentation on Mendelian and non –Mendelian inheritance, study of mutants of Drosophila through charts/photographs

## B.Sc. II Year

### Course V: Chordates (BSCZO201)

#### Course objectives:

1. To understand the systemic and functional morphology of various groups of chordates.
2. To study their affinities and adaptations to different modes of life.
3. To describe and explain the basic biology, evolution and classification of vertebrates and the other forms.
4. To impart knowledge in comparative anatomy and development systems of chordates.
5. To understand the ecological and economic importance of major chordate groups

#### Syllabus

Origin, ancestry, introduction and Characters of chordates. Classification of chordates up to order level. General characters and classification up to order level. Study of *Balanoglossus* and its affinities. General characters and classification up to order level. Study of *Herdmania* and its affinities. General characters and classification up to order level, study of *Branchiostoma (Amphioxus)* and its affinities. General characters and classification up to order level, Study of *Petromyzon* and its affinities. Types of scales and fins of fishes, *Scoliodon* as type study, migration and parental care in fishes. General characters and classification upto order level of *Rana tigrina* as type study, parental care, neoteny and paedogenesis. Adaptive features of Anura, Urodela & Apoda. General characters and classification up to order level, extinct reptiles. Study of *Uromastyx*, Identification of poisonous and non-poisonous snakes and biting mechanism of snakes. General characters and classification up to order level. Study of *Columba* (Pigeon) and Characters of Archaeopteryx. Flight adaptations, migration, ratitae and economic importance of birds. General characters and classification up to order level, affinities of Prototheria, Metatheria and Eutheria. Study of rabbit (*Oryctolagus*) and dentition in mammals. Economic importance of Mammals.

#### UNIT SCHEDULE

##### Block I (Primitive chordates)

- Unit 1: Origin of chordates
- Unit 2: Hemichordata
- Unit 3: Urochordata
- Unit 4: Cephalochordata
- Unit 5: Cyclostomata (Agnatha)

##### Block II (Lower chordates)

- Unit 6: Fishes
- Unit 7: Amphibia
- Unit 8: Reptilia

##### Block III (Higher chordates)

- Unit 9: Aves
- Unit 10: Mammalia

## Course V: Chordates (BSCZO201)

### UNIT WISE CONTENTS (BSCZO201)

#### Block I (Primitive chordates)

##### Unit 1: Origin of chordates

Introduction and characters of chordates. Classification of chordates up to order level.

##### Unit 2: Hemichordata

General characters and classification up to order level. Study of *Balanoglossus* and its affinities.

##### Unit 3: Urochordata

General characters and classification up to order level. Study of *Herdmania* and its affinities.

##### Unit 4: Cephalochordata

General characters and classification up to order level. Study of *Branchiostoma (Amphioxus)* and its affinities.

##### Unit 5: Cyclostomata (Agnatha)

General characters and classification up to order level. Study of *Petromyzon* and its affinities.

#### Block II (Lower chordates)

##### Unit 6: Fishes

General characters and classification up to order level. Types of scales and fins of fishes, *Scoliodon* as type study, migration and parental care in fishes.

##### Unit 7: Amphibia

General characters and classification up to order level, *Rana tigrina* as type study, parental care, neoteny and paedogenesis.

##### Unit 8: Reptilia

General characters and classification up to order level, extinct reptiles. *Uromastyx* as type study. Identification of poisonous and non-poisonous snakes and biting mechanism of snakes.

### **Block III (Higher chordates)**

#### **Unit 9: Aves**

General characters and classification up to order level. Study of *Columba* (Pigeon) and Characters of Archaeopteryx. Flight adaptations & bird migration.

#### **Unit 10: Mammalia**

General characters and classification upto order level, affinities of Prototheria, Metatheria and Eutheria. Study of rabbit (*Oryctolagus*) and dentition in mammals. Economic importance of mammals.

#### **Suggested Readings:**

1. Jordan E.L. and P.S. Verma 1995. Chordata Zoology and elements of Animal Physiology. S. Chand and Co., New Delhi.
2. Kotpal R.L. 2012. Vertebrata, Rastogi Publications, Meerut
3. Nigam.H.C. 1983. Zoology of chordates, Vishal publications, Jalandhar.
4. Waterman, Allyn J.et al.1971, Chordate Structure and functions. Mac.Millan and Co., New York.
5. Hyman. L.H. Comparative vertebrate Zoology. McGraw Hill Co., New York.

## **Course VI: Environmental Biology & Animal Behavior (BSCZO202)**

### **Objectives**

1. To realize the importance of inter relationship between every organism and environment.
2. To study the impact of eco factors on the morphology & distribution of organisms.
3. To understand the interactions between organisms and their environments, and the consequences of these interactions in natural populations, communities, and ecosystems.
4. To develop the understanding on the ecological realm of biology that integrates the interactions and interdependencies between organisms and their environment.
5. To study functional process the environment, biosphere and biogeochemical cycles.
6. To develop understanding of current global issues such as global warming, pollution, environmental deterioration, loss of biodiversity, climate change, etc.
7. To study the various aspect of conservation biology through the study of Protected Area Network.
8. To develop understanding on the evolutionary approach – how animals behave (i.e., the proximate, or mechanistic perspective) and why they behave in a certain way (i.e., the ultimate, or evolutionary perspective).

### **Syllabus:**

Basic concept of ecology, definition, types of ecology, significance, concepts of habitat and ecological niche. Abiotic and biotic factors. Factors affecting environment (light intensity, temperature, humidity, topography, edaphic factors). Producer, consumer and decomposer. Primary and secondary productivity. Major ecosystems (Freshwater, marine, forest and desert). Concept, component and their function, energy flows, food chain, food web, trophic structures and ecological pyramids. Introduction of law of limiting factors. Biosphere: Hydrosphere, Lithosphere and Atmosphere. Biogeochemical cycles (nitrogen, carbon, and hydrogen and oxygen cycle). Biodiversity - Definition - genetic, species and ecosystem diversity. Importance of biodiversity. Hotspots, threats to biodiversity - conservation of biodiversity. Principles of wildlife management, Protected Areas & Wildlife habitat in India: wildlife sanctuaries, National Parks and Biosphere reserves in India, endangered and threatened animal's species in India. Wildlife Protection Acts: 1972 and Biodiversity Act (2001). Protected area network initiative in Uttarakhand: Wildlife Sanctuaries, National Park, Biosphere Reserves. Major endangered fauna representing to PA's of Uttarakhand State. Air pollution, water pollution, noise pollution and soil pollution. Biodegradable and non-degradable pollutants and Biomagnifications and Bioremediations. Disaster Management - Floods, Earth quake, Cyclone and Landslides. Biomagnifications and Bioremediation. Types of behavior, behavioral equipments (senses, organs), Individual behavior pattern and homing behavior. Courtship and ritual behavior, mating, parental care in Amphibia and Primates. Social life in termites, dance language of the honey bees, Biological clocks, Migration in birds and fishes.

### **UNIT SCHEDULE**

#### **Block I: Environmental Biology**

**Unit 1:** Ecological concept

**Unit 2:** Environment

**Unit 3:** Ecosystems

**Unit 4:** Biosphere

**Unit 5:** Biogeochemical Cycles

## **Block II: Biodiversity Conservation and Management**

**Unit 6:** The concept of Biodiversity, Conservation and Management

**Unit 7:** Protected Area Network in Uttarakhand

**Unit 8:** Environmental Pollution and Management

**Unit 9:** Policies and Regulation

## **Block III: Animal Behavior**

**Unit 10:** Concepts and patterns of behavior

**Unit 11:** Social organization

## UNIT WISE CONTENTS (BSCZO202)

### **Block I: Environmental Biology**

#### **Unit 1:** Ecological concept

Basic concept of ecology, definition, types of ecology, significance, concepts of habitat and ecological niche.

#### **Unit 2:** Environment

Abiotic and biotic factors. Abiotic factors (Light intensity, temperature, humidity, topographic and edaphic factors). Producer, consumer and decomposer. Primary and secondary productivity.

#### **Unit 3:** Ecosystems

Major ecosystems (Freshwater, marine, forest and desert). Concept, component and their function, energy flows, food chain, food web, trophic structures, ecological pyramids. Introduction of law of limiting factors.

#### **Unit 4:** Biosphere

Hydrosphere, Lithosphere and Atmosphere.

#### **Unit 5:** Biogeochemical cycles

Biogeochemical cycles (nitrogen, carbon, and hydrogen and oxygen cycles).

### **Block II: Biodiversity Conservation and Management**

#### **Unit 6:** The concept of Biodiversity, Conservation and Management

Biodiversity - Definition - genetic, species and ecosystem diversity. Importance of biodiversity. Hotspots, threats to biodiversity - conservation of biodiversity. Principles of wildlife management, Protected Areas & Wildlife habitat in India: Wildlife sanctuaries, National Parks and Biosphere reserves in India, endangered and threatened species of animals in India. Wildlife Protection Acts 1972 and Biodiversity Act (2001).

#### **Unit 7:** Protected Area Network in Uttarakhand

Protected area network initiative in Uttarakhand: Wildlife Sanctuaries, National Park, Biosphere Reserves. Major endangered fauna representing to PA's of Uttarakhand State.

#### **Unit 8:** Environmental Pollution and Management

Air, water, noise and soil pollution. Biodegradable and non-biodegradable pollutants, Biomagnifications and Bioremediations.



### **Unit 9: Policies and Regulation**

Disaster Management - Floods, Earth quake, Cyclone and Landslides. Biomagnifications and Bioremediation.

### **Block II: Animal Behavior**

#### **Unit 10: Concepts and patterns of behavior**

Types of behavior, behavioral equipments (senses, organs), Individual behavior pattern and homing behavior. parental care in Amphibian.

#### **Unit 11: Social organization**

Social life in termites, dance language of the honey bees, Biological clocks, Migration in birds and fishes.

### **Suggested Readings:**

#### **Ecology & Environmental Management**

1. Cunningham and Cunningham: Environmental Science (2003, McGraw Hill)
2. Odum: Fundamental of Ecology (1971, Saunders)
3. Raven, Berg and Jhonson: Environment (1993, Saunders)
4. Ricklefs: Ecology (1990, Freeman)
5. Sharma: Ecology and Environment (2003, Rastogi)
6. Turk and Turk: Environmental Science (1998, Saunders)
7. Rajmannar. 2004. Environmental Studies. EVR College Publication, Trichy, India.
8. Kalavathy. S. (ED). 2004. Environmental Studies, Bishop Heber College Publicaion, Trichy.
9. Drickamer & Vessey : Animal Behaviour – concepts, processes and methods (2nd ed. 1986, Wadsworth,)
10. Freeland: Problems in Practical Advanced Level Biology (1985, Hodder & Stoughton,)
11. Goodenough et al.: Perspectives on Animal Behaviour (1993, Wiley)
12. Grier: Biology of Animal Behaviour (1984, Mosby)
13. Lorenz: The Foundation of Ethology (1981, Springer)
14. Manning & Dawkins: An Introduction to Animal Behaviour (5th ed. 1998, Cambridge).
15. Mcfarland : Animal Behaviour, Psychology, Ethology and Evolution (1985, Pitman).
16. Slater: An Introduction to Ethology (1985, Cambridge)

## **Course VII: Developmental Biology and Applied Zoology (BSCZO203)**

### **Course objectives:**

1. The general objective of the course is to understand and appreciate some of the events and processes which occur during animal growth and development, as the animal develops from an egg and a sperm into an adult organism.
2. To develop understanding how the process of differentiation leads to many different types of cells and tissues which function in an integrated way as each new organism develops.
3. To strengthen the knowledge in the field of applied zoology including animal pests in agriculture, horticulture, forests, fisheries science, veterinary, dairy, biomedical sciences and other allied fields.
4. To study the insect species causing damage to the crops in the field as well as under storage condition and the effective control measures against them.

### **Syllabus**

Types of egg, Spermatogenesis and Oogenesis. Fertilization: Chemical and metabolic events during gamete formation. Approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, prevention of polyspermy. Patterns of cleavage, control of cleavage patterns, chemical changes during cleavage and significance of cleavage. Embryonic induction and concept of organizer. Formation of Fate maps and Foetal membrane in frog and chick. Significance of Fate and Foetal membrane. General principles of aquaculture: Induced Breeding, Composite fish culture, Lay out of fish farm and its management and by-products of fishing industry. Prawn culture and Pearl culture. Different kinds of silk producing insects. Host plants of silk insects. Grainage, rearing, breeding and diseases of silkworm. Reeling and fiber technology. Honey bee found in India and, different kinds of hives. Management of bee colonies, bee enemies and their control. Extraction and processing of honey. Role of Honey bees in pollination management of agro-horticultural crops. Different kinds of Lac producing insects. Host plants, life cycle and diseases of lac insects. Types of poultry breeds, poultry housing, farm and farm management. Grading, handling and marketing of eggs. Poultry diseases and their control. Economic Importance of mammals in agriculture, horticulture, dairy, leather, wool and fur industry. Store grains pests: Their systematic positions, habits, life cycle, nature of damage and control measures. Biological and Chemical control: Elementary knowledge of pesticides and integrated pest management. General characters and Classification up to order level, morphology (including adaptations), life cycle, pathogenicity, diseases and control measures of parasitic animals.

### **UNIT SCHEDULE**

#### **Block I: Developmental Biology**

Unit 1: Gametogenesis

Unit 2: Fertilization

Unit 3: Cleavage and Embryonic Induction

Unit 4: Blastulation and Gastrulation in Frog and Chick

#### **Block II. Applied Zoology**

Unit 5: Aquaculture

Unit 6: Sericulture

Unit 7: Apiculture

Unit 8: Lac Culture

Unit 9: Poultry

Unit 10: Economic importance of Mammals

Unit 11: Store grain pests

Unit 12: Pest Management

Unit 13: Parasitology

## **Course VII: Developmental Biology and Applied Zoology (BSCZO203)**

### **UNIT WISE CONTENT (BSCZO203)**

#### **Block I Developmental Biology:**

##### **Unit 1: Gametogenesis**

Types of eggs, Spermatogenesis and Oogenesis. Chemical and metabolic events during gamete formation.

##### **Unit 2: Fertilization**

Approximation of gametes, Capacitation, Acrosome reaction, formation of fertilization membrane, egg activation, prevention of polyspermy.

##### **Unit 3: Cleavage and embryonic induction**

Patterns of cleavage & control of cleavage patterns, chemical changes during cleavage and significance of cleavage. Embryonic induction and concept of organizer.

##### **Unit 4: Blastulation and Gastrulation in Frog and Chick**

Fate maps, Foetal membranes: Their formation and significance.

#### **Block II. Applied Zoology**

##### **Unit 5: Aquaculture**

General principles of aquaculture: Induced Breeding, Composite fish culture, Lay out of fish farm and its management and by-products of fishing industry. Prawn culture and Pearl culture.

##### **Unit 6: Sericulture**

Different kinds of silk producing insects. Host plants of silk insects. Rearing and diseases of silkworm. Reeling and fiber technology.

##### **Unit 7: Apiculture**

Honey bees of India. Management of bee colonies, bee enemies and their control. Extraction and processing of honey. Role of Honey bees in pollination.

##### **Unit 8: Lac Culture**

Different kinds of Lac producing insects. Host plants, life cycle and diseases of lac insects.

##### **Unit 9: Poultry**

Types of poultry breeds, poultry housing, farm and farm management. Grading, handling and marketing of eggs. Poultry diseases and their control.

**Unit 10:** Economic importance of Mammals

Economic Importance of mammals in agriculture, horticulture, dairy, leather, wool and fur industry.

**Unit 11:** Store grain pests

Store grains pests: Pulse beetle (*Callosobruchus maculatus*), Rice weevil (*Sitophilus oryzae*), Wheat weevil (*Trogoderma granarium*), Rust red flour beetle (*Tribolium castaneum*) and Lesser grain borer *Rhyzopertha dominica*). Their systematic positions, habits, life cycle, nature of damage and control measures.

**Unit 12:** Pest Management

Biological and Chemical control: Elementary knowledge of pesticides and integrated pest management.

**Unit 13:** Parasitology: General characters and Classification up to order level, morphology (including adaptations), life cycle, pathogenicity, disease caused and control measures of *Entamoeba*, *Trypanosoma*, *Leishmania*, *Giardia*, *Ascaris*, *Ancylostoma*, *Enterobius*, *Wuchereria* and *Schistosoma*.

## **Course VIII: Laboratory Course (BSCZO204)**

### **Course Objectives:**

1. Describe and explain the basic principles of animal classification, form and function among Vertebrate phyla
2. Identify and classify the main groups of vertebrates
3. To develop understanding on osteology of chordates by the skeleton observation of Frog, *Varanus* (*Varanus*), Fowl and Rabbit
4. To study the histology through the permanent slide observation of different chordate groups.
5. To study the chordate anatomy through the dissection of fish, frog, rabbit or available mammal species.
5. To study the differential developmental stages of chick and frog by the whole mount slide observation
6. To understand the ecological process through the water sample analysis

**Syllabus:** Museum Specimens study of Protochordata, Pisces, Amphibia, Reptilia, Aves and Mammalia. Dissection study including general anatomy of Fish, Frog and available species of mammals. Study of skeleton of Frog, *Varanus*, Fowl and Rabbit. Permanent slides preparation of the body parts of pisces, Amphibia and Aves. Study permanent slides of protochordata, Amphibia, Aves and Mammalia. Study water quality and pollution. Study of wild animals and effect of pollutants on animals. Embryological slides of chick and frog showing the different developmental stages. Specimens, picture and slide study of economically important animals

### **UNIT SCHEDULE**

#### **Block I: Chordata**

- Unit1: Protochordata (study of Permanent slides & Museum specimens)  
Unit 2: Pisces (Dissection including general anatomy, Preparation of permanent slides, study of slides, museum specimens).  
Unit 3: Amphibia (study dissection, skeleton, histology and museum specimens)  
Unit 4: Reptilia (Study of *Varanus* skeleton & Museum specimens)  
Unit 5: Aves (Study of: Permanent slides, Skeleton and Museum specimens)  
Unit6: Mammalia (Study of animal dissection, skeleton, permanent slides and museum specimens)

#### **Block II: Ecology Experiments & Environmental Biology**

- Unit 7: Ecology Experiments & Environmental Biology  
Water quality and Pollutants & Study of wild animals

#### **Block III: Applied and Developmental Biology**

- Unit 9: Developmental biology (Permanent slides of chick & Frog embryology)  
Unit 10: Applied Zoology (Specimens, picture and slide study of economically important animals)

## UNIT WISE CONTENT (BSCZO204)

A complete record of laboratory work will be maintained by every student. The practical work will be consists of following:

### Block I: Chordata

#### Unit1: Protochordata (study of Permanent slides & Museum specimens)

- 1.1 Study of Permanent slides: *Amphioxus* and *Balanoglossus* passing through different body regions, *Doliolum*, *Salpa*, *Oikopleura*
- 1.2 Museum specimens of *Herdmania*, *Ciona* and *Balanoglossus*.
- 1.3 Cyclostomata: Museum specimens of *Petromyzon* and *Myxine*

#### Unit 2: Pisces (Fishes)

- 2.1 Model on general anatomy, afferent and efferent branchial arteries, cranial nerves and internal ear of *Scoliodon*
- 2.2 Study of permanent slides of shark T.S. Passing through different body regions and different kinds of scales of fish.
- 2.3 Study of Museum specimens of following: *Sphyrna*, *Pristis*, *Torpedo*, *Trygon*, *Acipenser*, *Polypterus*, *Hippocampus*, *Exocoetus*, *Anguilla*, *Echeneis*, *Diodon*, *Protopterus*, *Synaptura* and *Chimera*

#### Unit 3: Amphibia

- 3.1 Model on cranial nerves, hyoid apparatus, brain and columella of frog.
- 3.2 Study of skeleton of frog and permanent histological slides of amphibia.
- 3.3 Study of museum specimens of *Salamandra*, *Proteus*, *Amphiuma*, *Necturus*, *Siren*, *Ambystoma*, *Axolotl* larva, *Rhacophorus*, *Alytes* and *Hyla*, *Pipid* and *Bufo*.

#### Unit 4: Reptilia

- 4.1 Study of skeleton of *Varanus*.
- 4.2 Study of museum specimens of following: *Varanus*, *Heloderma*, *Hemidactylus*, *Phrynosoma*, *Chameleon*, *Draco*, *Calotes*, *Cobra*, Pit-viper, Pitless viper, Rattle snake, Krait, Dhaman, Typhlops and marine snake, Alligator, Crocodile, Gavialis, Turtle and Tortoise.

#### Unit 5: Aves

- 5.1. Study of the skeleton of fowl.
- 5.2. Study of museum specimens of following: *Psittacula*, *Corvus*, *Pavo*, *Bubo*, and model/chart of Archaeopteryx.

#### Unit 6: Mammalia

- 6.1 Study of permanent slides of mammals.
- 6.2 Study of the skeleton of rabbit

- 6.3 Study of the museum specimens of *Tachyglossus* and *Ornithorhynchus* (models), *Pangolin*, *Funambulus*, *Pteropus* and *Loris*.

## **Block II. Ecological Experiment & Environmental Biology**

### **Unit 7: Ecological Experiment & Environmental Biology**

- 7.1 Estimation of pH of water/ soil sample.
- 7.2 Determination of dissolved oxygen and carbon dioxide in water sample.
- 7.3 Study of adaptations in animals inhabiting different ecological environments.
- 7.4 Study of wild animals with the help of models/charts/photographs
- 7.5 Study of Rare and Endangered faunal species of the Uttarakhand State through charts and photograph
- 7.6 Study of wild animals with the help of models/charts/photographs
- 7.7 Study of Rare and Endangered faunal species of the Uttarakhand State through charts and photograph

### **Unit 8: Developmental Biology**

- 9.1. Study of permanent slides of the chick embryos (whole mounts)
- 9.2. Study showing the embryology of frog.

### **Unit 9: Applied Zoology**

- 10.1 Specimens/ slides of *Apis*, Silk moth, Lac insect,
- 10.2 Phytoparasitic nematodes, major crops and store grain pests
- 10.3 Pictures of economically important varieties of poultry and cattle
- 10.4 Parasites/Slides *Entamoeba*, *Trypanosoma*, *Leishmania*, *Giardia*, *Ascaris*, *Ancylostoma*, *Enterobius*, *Wuchereria* and *Schistosoma*.



## **B.Sc. III Year**

### **Course IX: Physiology and Biochemistry (BSCZO301)**

#### **Course objectives:**

1. To define and explain the basic principles of biochemistry
2. An understanding of the mechanisms of regulation of metabolic processes
3. To understand the interdependent relationship between enzyme catalysis, metabolism, regulation and their importance to the physiological condition of an organism.
4. To study the basic principles of animal physiology, chemical and physical properties of living matter
5. To understand the physiology of various organs and organ systems

#### **Syllabus**

Intracellular and extracellular digestion. Intestinal digestion - Pancreatic secretion, bile juices and digestion in small intestine, digestion and absorption in large intestine. Digestion and absorption of carbohydrate, fat and protein and regulation of enzyme action. Types of respiration. Breathing mechanism, pulmonary ventilation, respiratory pigments, gaseous transport and respiratory quotient. Composition and functions of blood, Blood groups, Rh factor. Mechanism of blood clotting. Types of heart, Cardiac cycle and its regulation (Heart beat). Homeostasis. Blood pressure and ECG. Structure of kidney. Mode of excretion of nitrogenous wastes in animals: ammonotelism, ureotelism, uricotelism and guanotelism. Myelinated and non-myelinated nerve fibres. Neurotransmitters. Synapses: - Ultra structure and function. Resting and action potential of nerves, synapse and transmission of nerve impulse. Ultra structure of smooth, striated and cardiac muscles. Muscle contraction and its mechanism and simple twitch and fatigue. General characteristics of endocrine system. Structure and functions endocrine system and its dysfunctions and diseases. Structures of Biomolecules, classification and properties of peptide bond. Definition, Classification, Metabolism: -Glycogenesis, Gluconeogenesis, Glycolysis, TCA and oxidative phosphorylation of Carbohydrates. Definition, classification, simple, compound and derived lipids. Source, significance & diseases due to the deficiency of Carbohydrates and Lipids. Classification, structure, occurrence and functions of fat and water soluble vitamins. Source, significance & diseases due to the deficiency of Vitamins. Definition, classification, structure and metabolism of proteins. Source, significance and diseases due to the deficiency of protein or outcome of protein deficiency- would be better. Definition, properties, classification, mechanism of enzyme action and factors affecting enzyme action. Source, significance & deficiencies of Enzymes.

#### **UNIT SCHEDULE**

##### **Block I. Physiology**

- Unit 1: Digestive System
- Unit 2: Respiratory System
- Unit 3: Blood Vascular System
- Unit 4: Excretory System
- Unit 5: Nervous System
- Unit 6: Muscular System

##### **Block II. Endocrinology**

Unit 7: Endocrine system

Unit 8: Hormonal Dysfunction and Diseases

**Block III Bio-chemistry**

Unit 9: Amino Acids and Peptides.

Unit 10: Carbohydrates and Lipids

Unit 11: Vitamins

Unit 12: Proteins

Unit 13: Enzymes

## **Physiology and Biochemistry (BSCZO301)**

### **UNIT WISE CONETENT (BSCZO301)**

#### **Block I. Physiology**

##### **Unit 1: Digestive System**

Intracellular and extracellular digestion. Intestinal digestion - Pancreatic secretion, bile juices and digestion in small intestine, digestion and absorption in large intestine. Digestion and absorption of carbohydrate, fat and protein and regulation of enzyme action.

##### **Unit 2: Respiration or Respiratory System**

Types of respiration. Breathing mechanism, pulmonary ventilation, respiratory pigments, gaseous transport and respiratory quotient.

##### **Unit 3: Blood Vascular System**

Composition and functions of blood, Blood groups, Rh factor. Mechanism of blood clotting. Types of heart, Cardiac cycle and its regulation (Heart beat). Homeostasis. Blood pressure and ECG.

##### **Unit 4: Excretory system**

Structure of kidney. Mode of excretion of nitrogenous wastes in animals: amonotelism, ureotelism, uricotelism and guanotelism.

##### **Unit 5: Nervous system**

Myelinated and non-myelinated nerve fibres. Neurotransmitters. Synapses: - Ultra structure and function. Resting and action potential of nerves, synapse and transmission of nerve impulse.

##### **Unit 6: Muscular System**

Ultra structure of smooth, striated and cardiac muscles. Muscle contraction and its mechanism. Simple twitch and fatigue.

#### **Block II. Endocrinology**

##### **Unit 7: Endocrine system**

General characteristics of endocrine system. Basic introduction of Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and ovary in mammals.

##### **Unit 8: Hormonal dysfunction and diseases**

Dwarfism, Gigantism, Acromegaly, Diabetes insipidus and Diabetes mellitus, Goitre, Cretinism. Myxoderma and Addison's disease.

## **Block III Biochemistry**

### **Unit 9: Amino Acids and Peptides.**

Bimolecular structure, classification and properties of peptide bond

### **Unit 10: Carbohydrates and Lipids**

Definition, Classification, Metabolism: - Glycogenesis, Gluconeogenesis, Glycolysis, TCA. & oxidative phosphorylation of Carbohydrates. Definition, classification of simple, compound and derived lipids. Source, significance & deficiencies (Deficiency) diseases of Carbohydrates and Lipids.

### **Unit 11: Vitamins**

Classification, structure, occurrence and functions of fat and water soluble vitamins. Source, significance & diseases due to the deficiency of vitamins.

### **Unit 12: Proteins**

Definition, classification, structure and metabolism of proteins. Source, significance and deficiencies of Proteins.

### **Unit 13: Enzymes**

Definition, properties, classification, mechanism of enzyme action and factors affecting enzyme action. Source, significance & deficiencies of Enzymes.

## **Suggested Readings:**

### **Animal Physiology**

1. William S.Hoar- General and Comparative Physiology, prentice hall of India ltd.
2. Wood E.W. Principle of Animal physiology
3. Nagbhushnum R.,Sarojini R., Kodarkar M.S. –Animal Physiology
4. Verma ,Agarwal & Tyagi-animal physiology
5. Moeye K.-Animal Physiology, Cambridge low prize edition.
6. Mohan Arora – animal physiology, Himalaya publication
7. A.K. Berry. –animal physiology
8. Singh. H.R.: An Introduction to Animal Physiology & related Biochemistry. S.I. Nagin Chand & Co.
9. Goel and Sastri : Animal Physiology, Rastogi Publications.
10. Rastogi. V.B. : Physiology and Endocrinology, Kedarnath Ramnath

### **Biochemistry and Endocrinology**

1. J.L. Jain –biochemistry S.Chand Publication, Meerut
2. Lehninger- Biochemistry, Kalyani Publications
3. Granner and Rodwell - Harper's Illustrated Biochemistry, Murray, (27th Ed.), McGraw Hill, USA .
4. J H Wet - General Biochemistry Wiley Eastern Ltd.
5. C.B.Powar- Biochemistry – (Himalaya Pub.)

## **Course X: Microbiology, Immunology and Toxicology (BSCZO302)**

### **Objectives:**

1. To emphasize the importance of integrating new knowledge on Microorganisms.
2. To update the Technological innovations of Microbial Genetics and their Application
3. To acquire a fundamental working knowledge of the basic principles of immunology
4. To develop understanding how immunological principles apply to the process of immune function

### **Syllabus**

Introduction to microbiology: Kinds of Microbes, Viruses, Archaea, Bacteria, Eukaryotic microorganisms and typical structure of bacterium and a virus. Culture and growth of microorganisms, classification of bacteria based on staining of microbes. Bacteria of medical importance – Gram positive and Gram Negative, Mycobacterium, Rickettsia and Actinomycetes. A brief knowledge of Mycoplasma and Aids. Useful microbial products: antibiotics, Food production, Dairy products. Alcoholic beverages, microbial spoilage and food preservation. Environmental use of microorganism: Metal recovery, petroleum recovery, waste treatment. Innate, Adaptive (cell mediated and humoral), Active and Passive immunity (Artificial and Natural). Organs of immune system: Primary and secondary lymphoid organs and lymphatic system. Antigen: Antigenicity, Adjuvants and Hapten. Immunoglobulins: types structure and function. Complement system (antigen – antibody reactions). Structural organization of MHC complex, Antigen processing and presentation. Functions of T-cells. Brief introduction to Vaccines, Immunodiagnosis and Immunotherapy. Kind and source of toxic agents: Synthetic organic compounds, natural occurring toxins, inorganic chemicals. Dose- response relationship. Routes of entry. Environmental movement and fate of toxin. Mode of action: chronic, Natural poisons. Toxic responses of blood. Organ function tests, teratogenic, reproductive and carcinogenic tests.

### **UNIT SCHEDULE**

#### **Block I: Microbiology**

Unit 1: Diversity of Microbes

Unit 2: Techniques in culture of microbes

Unit 3: Applied microbiology

#### **Block II: Immunology**

**Unit 4:** Overview of Immune System

**Unit 5:** Cells and organs of immune system

**Unit 6:** Humoral immunity

**Unit 7:** Cell mediated immunity

**Unit 8:** Applications of Immunology

#### **Block III: Toxicology**

**Unit 9:** Toxin

**Unit10:** Analytical toxicology

## UNIT WISE CONTENT (BSCZO302)

### **Block I: Microbiology**

#### **Unit 1:** Diversity of Microbes

Kinds of Microbes, Viruses, Archaea, Bacteria, Eukaryotic microorganisms and typical structure of bacterium and a Virus.

#### **Unit 2:** Culture of Microbes

Sterilization, disinfection, culturing, media preparation, Isolation, growth and identification of microorganism.

#### **Unit 3:** Applied microbiology

Bacteria of medical importance – Gram positive and Gram Negative, Mycobacterium Rickettsia and Actinomycetes. A brief knowledge of Mycoplasma and Aids. Useful microbial products: antibiotics, Food production, Dairy products. Alcoholic beverages, microbial spoilage and food preservation. Environmental use of microorganism: Metal recovery, petroleum recovery, waste treatment

### **Block II: Immunology**

#### **Unit 4:** Overview of Immune System

Innate, Adaptive (cell mediated and humoral), Active and Passive immunity (Artificial and Natural).

#### **Unit 5:** Cells and organs of immune system

Organs of immune system: Primary and secondary lymphoid organs and lymphatic system

#### **Unit 6:** Humoral immunity

Antigen: Antigenicity, Adjuvants and Hapten. Immunoglobulins: types structure and function. Complement system (antigen – antibody reactions)

#### **Unit 7:** Cell mediated immunity

Structural organization of MHC complex, Antigen processing and presentation. Functions of T-cells

#### **Unit 8:** Applications of Immunology

Brief introduction to Vaccines, Immunodiagnosis and Immunotherapy

### **Block III: Toxicology**

#### **Unit 9:** Toxin

Kind and source of toxic agents: Synthetic organic compounds, natural occurring toxins, inorganic chemicals. Dose- response relationship. Routes of entry. Environmental movement and fate of toxin. Mode of action: chronic, Natural poisons.

**Unit10:** Analytical toxicology: Toxic responses of blood. Organ function tests, teratogenic, reproductive and carcinogenic tests.

**Suggested Readings:**

**Microbiology**

1. Sharma, P.D. 1998: Microbiology – Rastogi Publ. Meerut, India
2. Subba Rao, N.S., 1999: Soil Microbiology, Oxford IBH Co. New Delhi, India.
3. Sullia, S.B. & Santharam, S. 2004-General Microbiology, Oxford IBH, India.
4. Parihar, L. 2008: Advances in Applied Microbiology - Agrobios Publ. India
5. Agarwal, A.K. 2008: Industrial Microbiology, Agrobios Publ. India.
6. Bohra, A. 2006: Food Microbiology, Agrobios Publ. India
7. Purohit, S.S. 2007: Microbiology - Agrobios Publ. India
8. Trivedi, P.C. 2008: Applied Microbiology - Agrobios Publ. India

**Immunology**

1. Roitt, I.M 2000 Essential Immunology, Blackwell scientific Publishers.
2. Paul, W.E.M. 1989, Fundamental Immunology, Raven press, New York.
3. Roitt, I., Brostoff, J. and Male. D. 2002. Immunology, Mosby, New York.

## **Course 11: Biostatistics, Instrumentation and Techniques (BSCZO303)**

### **Course Objectives:**

1. To get a basic knowledge of statistical methods and computations in biology.
2. To study the application of information sciences (mathematics, statistics and computer sciences) in biology.
3. To study the methods of data collection, compilation and presentation of biological data on different habitats and environmental regimes.
4. To know data representation through the tabular/ban/histogram/bar diagram and graphics representation
5. To correlate the field value with standard statistical methods
6. To develop the basic knowledge on various instruments and their techniques used for biological analysis
7. To develop the understanding on operating mechanism of various instruments used in field and laboratory analysis of biological study

### **Syllabus:**

Biostatistics as a tool in research and scope, Statistical symbols, Scope & Applications. Collection (Random and non random sampling), Organization and representation of data (Graph, Histogram, Scatter diagram). Mean, Mode and Median, Measures of Variability: Mean deviation, Standard deviation, Variance and coefficient of variation. pH meter, UV-visible spectrophotometer, Centrifuges (clinical, high-speed and ultra-centrifuge), Geiger Muller and scintillation counters. Tissue preparation, Fixation, Block preparation, Microtomy (paraffin and frozen tissue sectioning). Types of Microscopes: Bright field, Dark-field, Phase contrast, Fluorescence, Confocal and Scanning and transmission electron microscopes. Chromatography, Electrophoresis and cryopreservation.

### **UNIT SCHEDULE**

#### **Block I: Biostatistics**

Unit 1: Data collection and presentation

Unit 2: Measures of central tendency (mean, median and mode)

Unit 3: Variability/ Dispersion

#### **Block II: Instrumentation and techniques**

**Unit 4:** Principles and uses of analytical instruments

**Unit 5:** Microtomy and Microscopy

**Unit 6:** Separation techniques and cryopreservation



## **Biostatistics, Instrumentation and Techniques (BSCZO 303)**

### **UNIT WISE CONTENT (BSCZO 303)**

#### **Block I: Biostatistics**

##### **Unit 1:** Data collection and presentation

Definitions of biostatistics, Statistical symbol, Scope & Applications of biostatistics, Collection (Random and non random sampling or stratified sampling), Organization and representation of data (Graph, Histogram, Scatter diagram).

##### **Unit 2:** Measures of central tendency

Mean (Arithmetic), Mode and Median. Major Characteristics of each measures of central tendency. Advantage and disadvantage of mean, mode and median.

##### **Unit 3:** Measures of Variability/ Dispersion

Range, Interquartile Range, Mean deviation, Standard deviation, Variance and coefficient of variation.

#### **Block II: Instrumentation and techniques**

##### **Unit 4:** Principles and uses of analytical instruments

pH meter, UV-visible spectrophotometer, Centrifuges (clinical, high-speed and ultra- centrifuge), Geiger Muller and scintillation counters

##### **Unit 5:** Microtomy and Microscopy

Tissue preparation, Fixation, Block preparation, Microtomy (paraffin and frozen tissue sectioning). Types of Microscopes: Bright field, Dark-field, Phase contrast, Fluorescence, Confocal and Scanning and transmission electron microscopes.

##### **Unit 6:** Separation techniques and cryopreservation

Chromatography, Electrophoresis and cryopreservation

## **Course 12: Laboratory Course (BSCZO304)**

### **Course Objectives:**

1. To understand the blood physiology of the mammals i.e. hemoglobin %, RBC & WBC, Haematin crystal and blood groups, Rh factor etc.
2. To study the various biochemistry exercises relevant to human beings i.e., Chemical test of urine for the presence of urea, sugar, proteins and ketone bodies and color test for carbohydrates, proteins and lipids
3. To study the basic microbiology techniques i.e , isolation, staining, media preparation and culture
4. To study the identification of microbes through the staining techniques
5. To study the basics of biotechnological application and instrument used in biological techniques
6. To study the importance of biostatistics and bioinformatics for biological studies

### **Syllabus**

Measurement of action of salivary amylase, invertase enzyme, pepsin and trypsin. Blood physiology of mammals i.e. hemoglobin % RBC & WBC, Haematin crystal and blood groups, Rh factor etc. Biochemistry exercises relevant to human beings i.e., Chemical test of urine for the presence of urea, sugar, proteins and ketone bodies and color test for carbohydrates, proteins and lipids. Bio-techniques: uses of various instruments i.e, Microscopes, electrophoresis unit, spectrophotometer etc. Bioinformatics: Data search engines, Data search tools for bioinformatics, computer peripherals etc. Biostatistics study i.e., mean, median, mode, standard deviation, standard error from the data provided.

### **Unit Details**

Unit 1: Hematology Exercise

Unit 2: Physiology Experiment 2 (Slide study & reflex action)

Unit 3: Bio-chemistry Experiments

Unit 4: Immunology Experiment/study

Unit 5: Microbiology

Unit 6: Biotechniques (exercise based on chart / picture or sample instrument)

Unit 7: Biotechnology Exercise (I)

Unit 8 Biotechnology Exercise (II)

Unit 9: Biostatistics Exercise

## UNIT WISE CONTENT (BSCZO 304)

### Unit 1: Hematology Exercise

- 1.1 Estimation of hemoglobin, % RBC & WBC and preparation of Haematin crystal.
- 1.2 Estimation of presence of sugar and albumin in a sample of human urine.

### Unit 2: Physiology Experiment 2 (Slide study & reflex action)

- 2.1 Study of microscopic structure of endocrine glands: thyroid, pancreas, and ovary, testis, adrenal and pituitary
- 2.2 Study of estrous cycle in mice/rat.

### Unit 3: Bio-chemistry Experiments

- 3.1 Chemical test of urine for the presence of urea, sugar, proteins and ketone bodies.
- 3.2 Color tests for carbohydrates, proteins and lipids
- 3.3 Action of Amylase on its respective substrates.

### Unit 4: Immunology Experiment/study

- 4.1 DLC ( Differential Leukocyte Count)
- 4.2 Blood groups and Rh factors
- 4.3 Widal test for the identification of Typhoid
- 4.4 VDRL test for Syphilis

### Unit 5: Microbiology

- 5.1 Preparation of culture media, sterilization
- 5.2 Gram staining

### Unit 6: Biotechniques (exercise based on chart / picture or sample instrument)

- 6.1 Determination of pH using pH meter
- 6.2 Demonstration of functioning of spectrophotometer
- 6.3 Demonstration of use of bright field, phase contrast, dark field, fluorescence, confocal and electron microscopes (on photograph basis)

### Unit 7: Biotechnology/ Biotechnique Exercise (I)

- 7.1 Study of the principles and applications of the following equipment with the help of photographs/Diagram:
  - 7.1.1 Laminar flow
  - 7.1.2 Autoclave
  - 7.1.3 Elisa reader
  - 7.1.4 PCR machine
  - 7.1.5 Refrigerated centrifuge a

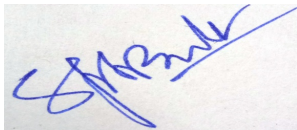
- 7.1.6 Tran illuminator
- 7.2 Double helical DNA Model
- 7.3 Chromatography or Thin Layer Chromatography (TLC)
- 7.5 Recombinant DNA techniques

Unit 8 Biotechnology/Biotechnique Exercise (II)

- 8.1 Study of prepared slides, models or specimen.
- 8.2 Escherichia coli
- 8.3 Bacteriophage
- 8.5 Plasmid
- 8.6 Southern blot
- 8.7 DNA Isolation
- DNA Replication

Unit 9: Biostatistics Exercise

- 10.1 Calculation of mean, median, mode, standard deviation, standard error from the data provided  
(Simple non scientific calculator may be used for calculation of data).



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