Double Minor Course

	X				Y			
	1st Minor		2nd Minor		1st Minor		2nd Minor	
	Zoology		Bot/Chem/Geo		Zoology		Bot/Chem/Geo	
	1st Paper	2nd Paper	1st Paper	2nd Paper	1st Paper	2nd Paper	1st Paper	2nd Paper
1st Semester	1.1		1.1		1.1		1.1	
2nd Semester	2.1		2.1		2.1		2.1	
3rd Semester	3.1		3.1	3.2	3.1		3.1	3.2
4th Semester	4.1	4.2 (3.2)	4.1		4.1	4.2 (3.2)	4.1	
5th Semester	5.1		5.1	5.2	5.1		5.1	5.2
6th Semester	6.1	6.2 (5.2)	6.1		6.1	6.2 (5.2)	6.1	

Semesters	Paper Code	Paper Title
1st Semester	MIN-ZOO-1.1	Principles of Ecology
2nd Semester	MIN-ZOO-2.1	Introduction to Non-Chordates
3rd Semester	MIN-ZOO-3.1	Diversity of Chordata
	MIN-ZOO-3.2	Physiology and Biochemistry
4th Semester	MIN-ZOO-4.1	Cell Biology and Genetics
	MIN-ZOO-4.2	Physiology and Biochemistry
5th Semester	MIN-ZOO-5.1	Molecular Biology and Evolution
	MIN-ZOO-5.2	Comparative Anatomy of Vertebrates
6th Semester	MIN-ZOO-6.1	Fundamentalof Biochemistry and Instrumentation
	MIN-ZOO-6.2	Comparative Anatomy of Vertebrates

B.Sc. 1st SEM

ZOO-MINOR

Course Title: Principles of Ecology
Course Code: MIN-ZOO-1.1
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Introduction to Ecology 6
History of ecology. Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors

Unit2: Population 24
Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies Population regulation-density-dependent and independent factors Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical responses

Unit3: Community 12
Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one example Theories pertaining to climax community

Unit4: Ecosystem 14
Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies Nutrient and biogeochemical cycle with one example of Nitrogen cycle, Human modified ecosystem

Unit 5: Applied Ecology 4
Ecology in wildlife conservation and management

PRACTICALS **(Credits 1)**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided

2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon- Weiner diversity index for the same community

3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method).

4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

B.Sc. 2nd SEM

ZOO-MINOR

Course Title: Introduction to Non-Chordates
Course Code: MIN-ZOO-2.1
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Protista and Protozoa 6
General characteristics and classification up to classes of Protista. Locomotion in protozoa.

Unit 2: Porifera 6
General characteristics and classification up to classes of Porifera. Canal system in sponges

Unit 3: Cnidaria 6
General characteristics and classification up to class. Polymorphism in Cnidaria.

Unit 4: Platyhelminthes 7
General characteristics and classification up to classes. Life cycle and pathogenicity of *Fasciola hepatica.*

Unit 5: Nemathelminthes 7
General characteristics and classification up to classes. Lifecycle and pathogenicity of *Ascaris lumbricoides*.

Unit 6: Introduction to Coelomates 4
Evolution of coelom.

Unit 7: Annelida 6
General characteristics and classification up to classes. Locomotion in leech.

Unit 8: Arthropoda 6
General characteristics and classification up to classes. Metamorphosis in Insect.

Unit 9: Mollusca 6

General characteristics and classification up to classes. Torsion and detorsion in Gastropoda.

Unit 10: Echinodermata 6
General characteristics and classification up to classes. Water-vascular system in Echinodermata.

PRACTICALS **Credits 1**

1. Study of whole mount of Euglena, Amoeba and Paramecium.

2 . Examination of pond water collected from different places for diversity in Protista

3. Study of Sycon (T.S. and L.S.), Hyalonema, Euplectella, Spongilla

4. Study of Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora

5. Study of adult *Fasciola hepatica*, *Taenia solium*.

6. Study of adult *Ascaris lumbricoides*.

7. Study of following specimens: Annelids-Aphrodite, Nereis, Heteronereis, Sabella, Limulus, Palamnaeus, Serpula, Chaetopterus, Pheretima, Hirudinaria Arthropods Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta, termites and honey bees Onychophora Peripatus Molluscs Echinus, Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus Echinodermates Cucumaria and Antedon Pentaceros/Asterias, Ophiura, Clypeaster,

8. Dissection of digestive system of Periplaneta.

9. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

B.Sc. 3rd SEM

ZOO-MINOR

Course Title: Diversity of Chordata
Course Code: MIN-ZOO-3.1
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Introduction to Chordates 2
General characteristics and outline classification

Unit2: Protochordata 8
General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates.

Unit 3: Origin of Chordata 3
Dipleurula concept and the Echinoderm theory of origin of chordates. Advanced features of vertebrates over Protochordata

Unit 4: Agnatha 2
General characteristics and classification of Cyclostomes up to class

Unit 5: Pisces 8
General characteristics of Chondrichthyes and Osteichthyes, classification up to order, Migration, Osmoregulation

Unit 6: Amphibia 6
General characteristics and classification up to order; Parental care in Amphibians

Unit 7: Reptilia 7

General characteristics and classification up to order, Poison apparatus and Biting mechanism in snakes

Unit 8: Aves 8

General characteristics and classification up to order. Principles and aerodynamics of flight, Flight adaptations and Migration in birds

Unit9: Mammals 8

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

Unit10: Zoogeography 8

Zoo geographical realms, Theories pertaining to distribution of animals, distribution of vertebrates in different realms

PRACTICALS **(Credits 1)**

1. **Protochordata**; Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata Sections of Balanoglossus through proboscis and branchio genital regions, Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slide of Herdmaniaspicules

2. **Agnatha:** Petromyzon, Myxine

3. **Pisces:** Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas, Flat fish

4. **Amphibia:** Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra

5. **Reptilia:** Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus. Key for identification of poisonous and non-poisonous snakes

6. **Aves:** Study of six common birds from different orders. Types of beaks and claws

7. **Mammalia:** Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous. Mount of Weberian ossicles of fish Power point presentation on study of any two animals from two different classes by students (may be included if dissections not given permission)

B.Sc. 3rd SEM

ZOO-MINOR

Course Title: Physiology and Biochemistry
Course Code: MIN-ZOO-3.2
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Digestion and Respiration
Physiology of digestion in the alimentary canal, Absorption of carbohydrates, proteins, and lipids; Pulmonary ventilation; respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood

Unit 2: Excretion and Cardiovascular System
Structure of nephron; mechanism of urine formation, Counter-current mechanism Composition of blood; haemostasis, Structure of heart; origin and conduction of cardiac impulse, Cardiac cycle

Unit 3: Reproduction and Endocrine Glands
Physiology of male reproduction: spermatogenesis; Physiology of female reproduction: oogenesis, menstrual cycle, hormonal control; Structure and function of pituitary, thyroid, parathyroid, pancreas, and adrenal glands

Unit 4: Nerve and Muscle
Resting membrane potential; graded potential; action potential: properties, origin, and conduction (myelinated and non-myelinated fibers), Mechanism of synaptic transmission
Mechanism of skeletal muscle contraction

Unit 5: Enzymes and Metabolism

Enzyme classification and nomenclature; mechanism of action; enzyme kinetics, Glycolysis; Krebs cycle; pentose phosphate pathway; electron transport chain, β-oxidation of fatty acids; transamination; deamination; urea cycle

PRACTICALS **(Credits 1)**

1. Demonstration of enzyme activity (e.g., salivary amylase).

2. Determination of haemoglobin content.

3. Measurement of blood pressure and pulse rate.

4. Study of permanent slides/models of various physiological systems

5. Experiments on muscle and nerve physiology (demonstration based).

6. Urine analysis for urea, sugar, and chloride.

B.Sc. 4th SEM

ZOO-MINOR

Course Title: Cell Biology and Genetics
Course Code: MIN-ZOO-4.1
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Over view of Cells 3
Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions.

Unit 2: Plasma Membrane 5
Various models of plasma membrane structure Transport across membranes: Active and Passive transport, Facilitated transport

Unit 3: Endomembrane System 6
Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

Unit 4: Mitochondria and Peroxisomes 7
Mitochondria: Structure. Semi-autonomous nature, ETS, Chemi-osmotic hypothesis. Peroxisomes

Unit 5: Nucleus 6
Structure of Nucleus: Nuclear envelope, Nucleolus Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome)

Unit 6: Cell Division 5
Cell cycle, mitosis and meiosis

Unit 7: Mendelian Genetics and its Extension 10
Mendelian Principles of inheritance, Incomplete dominance and codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked inheritance.

Unit 8: Linkage, Crossing Over, Mutations 12

Linkage and crossing over, Molecular mechanisms of crossing over including models of recombination, Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), genetic disease: causes and types.

Unit 9: Sex Determination 6

Sex determination in various organisms including human.

PRACTICAL **(Credits 1)**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis

2. Study of various stages of meiosis.

3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/cheek cells.

4. To study the Mendelian laws and gene interactions.

4. Linkage maps based on data from Drosophila crosses.

5. Study of human karyotype (normal and abnormal).

6. Pedigree analysis of some human inherited traits.

B.Sc. 4th SEM

ZOO-MINOR

Course Title: Physiology and Biochemistry
Course Code: MIN-ZOO-4.2
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Digestion and Respiration
Physiology of digestion in the alimentary canal, Absorption of carbohydrates, proteins, and lipids; Pulmonary ventilation; respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood

Unit 2: Excretion and Cardiovascular System
Structure of nephron; mechanism of urine formation, Counter-current mechanism Composition of blood; haemostasis, Structure of heart; origin and conduction of cardiac impulse, Cardiac cycle

Unit 3: Reproduction and Endocrine Glands
Physiology of male reproduction: spermatogenesis; Physiology of female reproduction: oogenesis, menstrual cycle, hormonal control; Structure and function of pituitary, thyroid, parathyroid, pancreas, and adrenal glands

Unit 4: Nerve and Muscle
Resting membrane potential; graded potential; action potential: properties, origin, and conduction (myelinated and non-myelinated fibers), Mechanism of synaptic transmission
Mechanism of skeletal muscle contraction

Unit 5: Enzymes and Metabolism

Enzyme classification and nomenclature; mechanism of action; enzyme kinetics, Glycolysis; Krebs cycle; pentose phosphate pathway; electron transport chain, β-oxidation of fatty acids; transamination; deamination; urea cycle

PRACTICALS **(Credits 1)**

1. Demonstration of enzyme activity (e.g., salivary amylase).

2. Determination of haemoglobin content.

3. Measurement of blood pressure and pulse rate.

4. Study of permanent slides/models of various physiological systems

5. Experiments on muscle and nerve physiology (demonstration based).

6. Urine analysis for urea, sugar, and chloride.

B.Sc. 5th SEM

ZOO-MINOR

Course Title: Molecular Biology and Evolution
Course Code: MIN-ZOO-5.1
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Nucleic Acids 4
Salient features of DNA and RNA Watson and Crick model of DNA

Unit 2: DNA Replication 6
DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative

Unit 3: Transcription 6
RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes, synthesis of rRNA and mRNA, transcription factors

Unit 4: Translation 9
Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation

Unit 5: Post Transcriptional Modifications and Processing of Eukaryotic RNA 6
Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA

Unit 6: Gene Regulation 6
Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon

Unit 7: 5

Life's Beginnings: Origin of photosynthesis, Evolution of eukaryotes.

Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

Unit 8: 10

Evidences of Evolution: Fossil record: types of fossils, transitional forms, geological time scale, Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium;

Unit 9: 8

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept. Modes of speciation allopatric, sympatric, Adaptive radiation/macroevolution (exemplified by Galapagos finches).

PRACTICALS **(Credits 1)**

1. Study of Polytene chromosomes from Chironomous / Drosophila larvae

2. Preparation of liquid culture medium (LB) and raise culture of *E.coli*

3. Quantitative estimation DNA using colorimeter (Diphenylamine reagent)

4. Study and interpretation of electron micrographs/ photograph showing
(a) DNA replication
(b) Transcription
(c) Split genes

5. Study of fossils from models/pictures

6. Study of homology and analogy from suitable specimens

7. Study and verification of Hardy-Weinberg Law by chi square analysis

B.Sc. 5th SEM

ZOO-MINOR

Course Title: Comparative Anatomy of Vertebrates
Course Code: MIN-ZOO-5.2
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Integumentary System 8
Structure, functions and derivatives of integument

Unit 2: Skeletal System 8
Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches

Unit 3: Digestive System 8
Alimentary canal and associated glands, dentition

Unit 4: Respiratory System 8
Skin, gills, lungs and air sacs; Accessory respiratory organs

Unit 5: Circulatory System 8
General plan of circulation, evolution of heart and aortic arches

Unit 6: Urinogenital System 6
Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

Unit 7: Nervous System
Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals

Unit 8: Sense Organs 6

Classification of receptors Brief account of visual and auditory receptors in man

PRACTICAL **(Credits 1)**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Fowl, Rabbit
3. Carapace and plastron of turtle/tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)

B.Sc. 6th SEM

ZOO-MINOR

Course Title: Fundamental of Biochemistry and Instrumentation
Course Code: MIN-ZOO-6.1
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Carbohydrates 7
Structure and Biological importance: Monosaccharides, Disaccharides. Polysaccharides and Glycoconjugates

Unit 2: Lipids 6

Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids,

Unit 3: Protein 10
Amino acids: Structure, Classification and General properties of amino acids; Physiological importance of essential and non-essential amino acids. Proteins: Bonds stabilizing protein structure; Levels of organization in proteins;

Unit 4: Enzymes 10
Nomenclature and classification; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax,

Unit 5: 8
Microscopy: Principles and applications of phase contrast, Fluorescence and confocal Microscopy.

Unit 6: 6
Immunological techniques: Immunodiffusion, Immunoelectrophoresis, Enzyme linked Immuno-absorbant assay (ELISA).

Unit 8: 7

Centrifugation: Density gradient and unit gravity centrifugation, tissue processing and Separation of various sub-cellular organelles by centrifugation

Unit 9: 6

Molecular separation Techniques: Ion-Exchange, Absorption, gel filtration and affinity chromatography, and HPLC.

PRACTICAL **(Credits 1)**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.
3. Action of salivary amylase under optimum conditions.
4. Separation of biomolecules by centrifugation.

B.Sc. 6th SEM

ZOO-MINOR

Course Title: Comparative Anatomy of Vertebrates
Course Code: MIN-ZOO-6.2
Nature of Course: MINOR
Total Credits: 4
Distribution of Marks: 60(Theory) + 25 (Practical)+15(Internal Assessment)

Theory **Credits 3**

Unit 1: Integumentary System 8
Structure, functions and derivatives of integument

Unit 2: Skeletal System 8
Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral arches

Unit 3: Digestive System 8
Alimentary canal and associated glands, dentition

Unit 4: Respiratory System 8
Skin, gills, lungs and air sacs; Accessory respiratory organs

Unit 5: Circulatory System 8
General plan of circulation, evolution of heart and aortic arches

Unit 6: Urinogenital System 6
Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri

Unit 7: Nervous System
Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals

Unit 8: Sense Organs 6

Classification of receptors Brief account of visual and auditory receptors in man

PRACTICAL **(Credits 1)**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Fowl, Rabbit
3. Carapace and plastron of turtle/tortoise
4. Mammalian skulls: One herbivorous and one carnivorous animal
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)