ZOOLOGY

The following syllabus has been prepared in accordance with the criteria announced by the Higher Education Commission of Pakistan.

SCHEME OF STUDIES:

PART-I (3RD YEAR)

Paper-I, Biodiversity-I (Invertebrate)	38 marks
Paper-II, Principle of Cell Biology & Genetics	37 marks
(Cell Biology, Genetics, Biochemistry, Animal Behaviour)	
Practical based on Paper-I & II	25 marks

Time 4 hours

PART-II (4th Year)

Paper-III, Biodiversity-II (Chordates)	38 marks
Paper-IV, Form & Function (Comparative Perspective)	37 marks
Practical based on Paper-III & IV	25 marks

Time 4 hours

DETAIL OF COURSES

PAPER-I (Biodiversity - I) (invertebrate)

1. **Place of Zoology In Science:**
   A One-world view: Genetic Unity,-The Fundamental Unit of life, Evolutionary Oneness and the Diversity of Life, Environment and World Resources; What is zoology? The Scientific Method
2. **Introduction:**
   Classification of Organisms; Evolutionary Relationships and Tree Diagrams, Patterns of Organization.
3. Animal-like Protists: The Protozoa
   Evolutionary Perspective; Life within a Single Plasma Membrane; Symbiotic Life styles. Protozoan Taxonomy: (upto phyla, subphyla and superclasses, wherever applicable). Pseudopodia and Amoeboid Locombtion; Cilia and Other Pellicular Structures; Nutrition; Genetic Control and Reproduction; Symbiotic Ciletes;

Further Phylogenetic Considerations.

4. Multicellular and Tissue Levels of Organization:
   Evolutionary Perspective: Origins of Multicellularity; Animal Origins. Phylum Porifera: Cell Types, Body Wall, and Skeletons; Water Currents and Body Forms; Maintenance Functions; Reproduction. Phylum Cnidaria (Coelenterata) The Body Wall and Nematocysts; Alternation of Generations, Maintenance Functions; Reproduction and Classification up to class. Phylum Ctenophora; Further Phylogenetic Considerations.
5. The Triploblastic, Acoelomate Body Plan:
   Evolutionary Perspective; Phylum Platyhelminthes: Classification up to classes, The Free Living Flatworms and the Tapeworms; Phylum Nemertea; Phylum Gastrotricha Further Phylogenetic Considerations.
6. The Pseudocoeiomaie Body Plan: Aschelminths
   Evolutionary Perspective; General Characteristics; -Classification up tb phyla with External Features; Feeding and the Digestive System; Other Organ Systems; Reproduction and Development of phylum Rotifera and phylum Nematoda; Phylum Kinorhyncha. Some Important Nematode Parasites of Humans; Further Phylogenetic Considerations.
7. Molluscan Success:
   Evolutionary Perspective: Relationships to other Animals; Origin of the Coelom; Molluscan Characteristics; Classification up to class. The Characteristics of Shell and Associated Structures, Feeding, Digestion, Gas exchange, Locomotion, Reproduction and Maintenance Functions and Diversity in Gastropods, Bivalves and. Cephalopods, Further Phylogenetic Considerations.
8. Annelida: The Metameric Body Form
   Evolutionary Perspective: Relationship to other Animals, Metamerism and Tagmatization; up to class. External Structure and Locomotion, Feeding and the Digestive System, Gas Exchange and Circulation, Nervous and Sensory Function, Excretion Regeneration, Reproduction and Development, in Polychaeta, Oligochaeta and Hirudinea; Further Phylogenetic Considerations.
9. The Arthropods: Blueprint for Success
   Evolutionary Perspective: Classification and Relationships to Other Animals; Metamerism and Tagmatization; The Exoskeleton; Metamorphosis; Classification

up to class; Further Phylogenetic Considerations.

10. The Hexapods and Myriapods:

Terrestrial Triumphs Evolutionary Perspective; Classification up to class External Structure and Locomotion, Nutrition and the Digestive System, Gas Exchange, Circulation and Temperature Regulation, Nervous and Sensory Functions, Excretion, Chemical Regulation, Reproduction and Developmpt in Hexapoda; Insect Behavior, Insects and Humans; Further Phylogenetic Considerations.

11. The Echinoderms

Evolutionary Perspective: Relationships to other Animals; Echinoderm Characteristics; Classification up to class. Maintenance Functions, Regeneration, Reproduction, and Development in Asteroida, Ophiuoidea, Echinoidea, Holothuroidea and Crinoidea; Further Phylogenetic Considerations: Some leser Known Invertebrates; The Lophophorates, Entoprocts, Cycliophores, and Chaetognaths.

Practical based on Paper -1 Biodiversity-I (Invertebrates)

1. Study of Euglena, Amoeba , Entomoeba, Plasmodium, Trypanosoma, Paramecium as representative of animal like protists (prepared slides).
2. Study of sponges and their various body form
3. Principal representatives of classes of phylum Cnidaria (Coelenterata)
4. Principal representatives of classes of phylum Platyhelminthes
5. Representative of phylum Rotifera, phylum Nematoda.
6. Principal representative of classes of phylum Mollusca.
7. Principal representative, as of classes of phylum Annelida
8. Principal representatives of classes of phylum Arthropoda and Echinodermate.
9. Dissection
   - **(a)** Earthworm or Leech
   - **(b)** Cockroach or Locust
   - **(c)** Freshwater muscle

   (Study of all major system)
11. Brief notes on medical' economic importance of the following. Plasmodium, Entamoeba histolytica Leishmania, liverfluke, Tapeworm, Earthworm, Silkworm Citrus butterfly.
12. Preparation of permanent stained slides of the followings:

Paramecium, Obelia, Daphnia, Cestode, Parapodia of Nereis:

DETAIL OF COURSES

PAPER-II (Principle of cell biology) (Genetics)

1. The Chemical Basis of Animal Life

   Atoms and Elements: Building Blocks of All Matter; Compounds Molecules: Aggregates of Atoms; Acids, Bases, and Buffers; The Molecules of Animals: Fractional account of Carbohydrates, Lipids, Proteins, Nucleotides and Nucleic Acids based on their' structural aspects.

2. Cells, Tissues, Organs, and Organ System of Animals:

   Structure and Functions of Cell Membranes; Various movements across Membranes; Cytoplasm, Organelles, and Cellular Components: Functional account of Ribosomes, Endoplasmic Retculum, Golgi Apparatus, Lysosomes Mitochondria, Cytoskeleton, Cillia and Flagella, Centrioles and Microtubules, and Vacuoles based on their structural aspects. The Nucleus: Nuclear envelope, Chromosomes and Nucleolus. Tissues Diversity in Epithelial Tissue, Connective Tissue, Muscle Tissue and Nervous Tissue to perform various functions. Structural integrations for functions in Organs and Organ Systems.

3. Energy and Enzymes: Life's Driving and Controlling Forces Energy and the Laws of Energy Transformation; Activation Energy, Enzymes: Structure, Function and Factors Affecting their Activity; Cofactors and Coenzymes; ATP: How' Cells convert Energy? An Overview.

4. How Animals Harvest Energy Stored in Nutrients:

   Glycolysis: The First Phase of Nutrient Metabolism, Fermentation: "Life without Oxygen"; Aerobic Respiration. The Major Source of ATP; Metabolism of Fats and Proteins; Control of Metabolism; The Metabolic Pool.

5. Cell Division

   Mitosis, Cytokinesis, and the Cell Cycle: An Overview; Control of the Cell Cycle; Meiosis: The Basis of Sexual Reproduction; Gamete Formation.

6. Inheritance Patterns:

   The Birth of Modern Genetics; Mendelian Inheritance Patterns, Other inheritancePatterns; Environmental Effects and Gene Expression.

7. Chromosomes and Gene Linkage:

   Eukaryotic Chromosomes; Linkage Relationships, Changes in Chromosome Number and Structure

8. Molecular Genetics: Ultimate Cellular Control DNA: The Genetic Material; DNA Replication in Eukaryotes; Genes in Action; Control of Gene Expression in Eukaryotes, Mutations; applications of Genetic Technologies. Recombinant DNA.

9. Ecology II: Individuals and Populations

   Animals and Their Abiotic Environment Populations; Interspecific Interactions

10. Ecology II: Communities and Ecosystem:

Community Structure and Diversity; Ecosystems; Ecosystems of the Earth; (Terrestrial and Aquatic) Ecological Problems, Human Population Growth, Pollution, Resource Depletion and Biodiversity.,

11. Animal Behuviour

Four Approaches to Animal Behaviour; Proximate and Ultimate Causes; Anthropomorphism, Development of Behavior; Learning, Control of Behavior;' Communication; Behavioral Ecology; Social Behavior.

Principle of Cell Biology & Genetics

PRACTICALS (based on Paper- II)

1. Tests for different carbohydrates, proteins and lipids. (Emphasis on the concept that tests materials have been ultimately obtained from living organisms).
2. Study of the prepared slides of squamous, cuboidal, columnar, epithelial tissues, adipose, connective, cartilage bone, blood, nervous, skeletal muscle, smooth muscle and cardiac muscle tissues.
3. Plasmolysis and deplasmolysis in blood.
4. Protein digestion by pepsin.
5. Study of mitosis in onion root tip.
6. Study of meiosis in grass hopper testis (students should prepare the slide).
7. Problem based study of Mendelian ratio in animals.
8. Multiple alleles study in blood groups.
9. Survey and study of a genetic factor in population and its frequency.
10. Study of karyotypes of Drosophila/Mosquito.
11. Study of cytochemical demonstration of DNA and RNA in protozoa and avian blood cell
12. Study of stages in the development of an Echinoderm.
13. Study of early stages in the development of a frog, chick and a mammal.
14. Demonstration of social behaviour (documentary film be shown).
15. Ecological notes on animals of a few model habitats.
16. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study):
17. Study of Human Blood Groups.
18. Study of Human Blood Cell.

PART-II(PAPER-III)

Biodiversity II chordates

1. Hemichordata and Invertebrate Chordates

   Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations.

2. The Fishes: Vertebrate Success in Water

   Evolutionary perseptive: Phylogentic relationship, survey of----------Agnatha and Gnathostomata; Evolutionary Pressures: Adaptations in Locomotion Nutrition and the Digestive System, Circulation, Gas Exchange, Nervous and Sensory Functions, Excretion and Osmoregulation Reproduction and Development; Further Phylogenetic Considerations.

3 Amphibians: The First Terrestrital Vertebrates

   Evolutionary Perspective: Phylogenetic Relationships; Survey of Order Caudata, Gymnophiona, and Anura. Evolutionary Pressures: Adaptations in External Structure and Locomotion, Nutrition and the Digestive System, Circulation, Gas Exchange, Temperature Regulation, Nervous and Sensory Functions, Excretion and Osmoregulation, Reproduction, Development, and Metamorphosis; Further Phylogenetic Considerations.

4. Reptiles: The First Amniotes

   Evolutionary Perspective: Cladistic Interpretation of the Amniotic Lineage; Survey of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilla; Evolutionary Pressures: Adaptations in External Structure and Locomotion, Nutrition and the Digestive System, Circulation, Gas Exchange, and Tawerature Regulation, Nervous and Sensory Functions, Excretion and Osmoregulation, Reproduction and Development; Further Phylogenetic Considerations.

5. Birds: Feathers, Flight, and Endothermy

   Evolutionary Perspective: Phylogenetic Relationships; Ancient Birds and the Evolution of Flight; Diversity of Modern Birds; Evolutionary Pressures: Adaptation in External Structure and Locomotion, Nutrition and the Digestive System, Circulation Gas Exchange, and Temperature Regulation, Nervous and Sensory Systems, Excretion and Osmoregulation, Reproduction and Development; Migration and Navigation.

6. Mammals: Specialized Teeth, Endothermy, Hair, and Vivipaitiy

   Evolutionary Perspective: Diversity of Mammals; Evolutionary Pressures: Adaptations in Externai Structure and Locomotion, Nutrition and the Digesiivu System, Circulation, Gas Exchange, and Temperature Regulation, Nervous and Sensory Functions, Excretion and Osmoregulation, behaviour, Reproduction and Behaviour,

7. Evolution: A Historical Persepective

Pre-Darwinian Theories of Change; Lamarck: An any Proponent of Evolution; Early Development of Darwin's Ideas of Evolution and Evidences; The Theory of Evolution by Natural Selection; Evolutionary Thought after Darwin; Biogeography.

8. Evolution and Gene Frequencies

The Modern Synthesis; A Closer Look; The Hardy-Weinberg Theorem; Evolutionary Mechanisms: Population Size, Genetic Drift, natural Selection, Gene Flow', Mutation, and Balanced Polymorphism; Species and Speciation; Rates of Evolution; Molecular Evolution; Mosaic Evolution.

BIODIVERSITY-II (Chordates)

PRACTICALS

1. Study of representative of Hemichordate and invertebrate chordate.
2. Representative groups of class fishes.
3. Representative groups of class Amphibia.
4. Representative groups of class Reptilia.
5. Representative groups of class Ayes.
6. Representative groups of class Mammalia.
7. Field trips to study animal diversity with emphasis on their adaptions.
8. Study of scales in fishes and reptiles; amphibian and mammalian skin; feathers in ayes.
9. Skeleton; study of skeleton of Labeo; frog, varanus, fowl and rabbit, adaptation of skeleton to their function should also be studies.
10. Dissection of
    - (i) scoliodon (OR) any easily available fish
    - (ii) frog
    - (iii) uromastix
    - (iv) pigeon
    - (v) rabbit (for studing the following system)
        - (a) Nervous system
        - (b) Digestive system
        - (c) Respiratory system
        - (d) Circulatory system
        - (e) Endocrine system
        - (f) Urinogential system

PAPER-IV

FORM & FUNCTION (COMPARATIVE PERSPECTIVE)

ANIMAL FORM AND FUNCTION: A COMPARLATIVE PERSPECTIVE

1. Protection, Support, and Movement

   Protection: The Integumentary System of Invertebrates and Vertebrates; 'Movement and Support: The Skeletal System of Invertebrates and Vertebrates; Movement: Non-muscular Movement; An Introduction to Animal Muscles; The Muscular System of Invertebrates and Vertebrates.

2. Communication I: Nerves

   Neurons: Structure and Function; Neuron Communication Introductory accounts of Resting Membrane Potential, Action Potential (Nerve Impulse) and Transmission of the Action Potential between Cells; Invertebrate and Vertebrate Nervous Systems. The Spinal Cord, Spinal Nerves, The Brain, Cranial Nerves and The' Autonomic Nervous System

3. Communication II: Senses

   Sensory Reception: Baroreceptors, Georeceptors, Hygroreceptors, Phonoreceptors, Photoreceptors, Proprioceptors, Tactile Receptors, and Thermoreceptors of invertebrates; Laterl Line System and Electrical Sensing, Lateral-Line System and Mechanoreception, Hearing and Equilibrium in Air, Hearing and Equilibrium in Water, Skin Sensors of Damaging Stimuli, Skin Sensors of Heat and Cold, Skin Sensors of Mechanical Stimuli, Sonar, Smell, Taste and Vision in Vertebrates.

4. Communication III: The Endocrine System and Chemical Messengers

   Chemical Messengers: Hormones Chemistry; and 'Their Feedback Systems; Mechanisms of Hormone Action; Some Hormone of Porifcra, Cnidarians; Platyhelminthes, Nermerteans, Nematodes, Molluscs, Annelids, Arthropods, and Echinoderms Invertebration; An Overview of the Vertebrate Endocrine System; Endocrine Systems of Vertebrates other Than Birds or Mammals; Endocrine Systems of Birds and Mammals.

5. Circulation, Immunity, and Gas Exchange

   Internal Transport and Circulatory Systems in Invertebrates: Characteristics of Invertebrate Coelomic Fluid, Hemolymph, and Blood Cells; Transport Systems in Vertebrates; Characteristics of Vertebrate Blood, Blood Cells and Vessels; The Heart and Circulatory Systems of Bony Fishes, Amphibians,' and Reptiles, Birds and Mammals; The Human Heart: Blood Pressure and the Lymphatic System; Immunity: Nonspecific Defenses, The Immune Response; Gas Exchange: Respiratory Surfaces; Invertebrate and Vertebrate ' Respiratory Systems: Cutaneous Exchange, Gills, Lungs, and Lung .Ventilation; Human Respiratory System: Gas Transport.

6. Nutrition and Digestion

Evolution of Nutrition; The Metabolic Fates of Nutrients in Heterotrophs;

Digestion; Animal for Getting and Using Food Diversity in Digestive Structures of Invertebrates and Vertebrates, The Mammalian Digestive System; Gastrointestinal Motility and its Control, Oral Cavity, Pharynx and Esophagus, Stomach, Small Intestine: Main Site of Digestion; Large Intestine; Role of the

Pancreas in Digestion; and Role of the Liver and Gall bladder in Digestion.

7. Temperature and Body Fluid Regulation

Homeostasis and Temperature Regulation; The Impact of Temperature on Animal life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals; Heat Production in Birds **and** Mammals; Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate Excretory system; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions.

8. Reproduction and Development

A sexual Reproduction in Invertebrates; Advantages and Disadaantages of Asexual Reproduction; Sexual Reproduction in Invertebrates; Advantages and Disadvantages of Sexual Reproduction; Sexual Reproduction in Vertebrates; Reproductive Strategies; Examples of Reproduction among Various Vertebrate Classes; The Human Male Reproductive System: Sperm transport and Hormonal Control, Reproductive, Function; The Human Female Reproductive System: Folliculogensis, transport and Hormonal Control, Reproductive Function; Hormonal Regulation in gestation; Prenatal Development and Birth Events of Prenatal Development: The Placenta; Birth, Milk Production and lactation.

9. Descriptive Embryology

Fertilization; Embryonic Development Cleavage and Egg Types; The primary Germ Layers and their Derivatives; Echinoderm Embryology; Vertebrate Embryology: The Chordate Body Plan, Amphibian Embryology, Development in Terrestrial Environments, Avian Embryology, The Fate of Mesoderm.

PRACTICAL (Based on Paper IV)

1. Study of the following prepared slides.
   (i) Mammalian skin
   (ii) Arteries & vein
   (iii) Small & large intestine

(iv) Stomach

(v) Pancrease

(vi) Liver

(vii) Testes

(viii) Ovaries

2. Study of cardiac cycle in Frog.
3. Study of contractility in skeletal muscle of frog.
4. Study of effect of different harmones (adrenaline & acetycholine) on cardiac activity of frog
5. Study of Embryonic development in chick.

IMPORTANT

The minimum details of the titles in the content are from the principle reference book Zoology by Miller and Harley 1999, 2002, which should be kept in view in teaching and assessments. Essay type questions should be avoided. Question preferably be splitted into parts involving different topics**.**

BOOKS FOR LECTURES

Principal Reference Book:

1. Miller, AS. and Harley, J.B., 1999 & 2002. ZOOLOGY, 4th & 5th Edition (International). Singapore: McGraw Hill. AddWonal Readings:
2. Hickman, C.P., Roberts, L.S. and Larson, A, 2001. INTEGRATED PRINCIPLES OF ZOOLOGY, 11th Edition (International). Singapore: McGraw Hill.
3. Pechenik, J.A, 2000. BIOLOGY OF INVERTEBRATES, 4th Edition (International). Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S., 2001. COMPARATIVE ANATOMY OF VERTEBRATES. New York: McGraw Hill.
5. Campbell, N.A., 2002. BIOLOGY, 6th Edition. Menlo Park, California: The Benjami DLC publishing Company, Inc.

BOOKS FOR PRACTICAL

1. Miller, S.A, 2002. GENERAL ZOOLOGY LABORATORY —MANUAL. 5th Edition (International) Singapore: McGraw Hill;
2. Hickman, C.P. and Kats, H.L., 2000. LABORATORY STUDIES IN INTEGRATED PRINCIPLES OF ZOOLOGY. Singapore: McGraw, Hill.