



Scheme of Studies BS Zoology Fall 2025

Additional Director Academics
University of Chitral

**Department of Zoology
University of Chitral**



Program Description

The Bachelor of Science in Zoology program is designed in accordance with the provisions of the HEC Undergraduate Education Policy V 1.1, as communicated through the HEC's letter No. HEC/CD/NCRC/ZOOLOGY/2025/7136 to provide students with a comprehensive and in-depth understanding of the diverse animal kingdom. This program integrates knowledge across various domains, including animal diversity, physiology, behavior, ecology, genetics, and evolutionary biology, equipping students with essential analytical, observational, and research skills. It prepares graduates for careers in zoology, biodiversity conservation, and environmental sciences, as well as for further academic pursuits in related fields.

Standard Nomenclature

1. Bachelor of Science in Zoology

The scheme of study prescribed for the four-year undergraduate degree in Zoology is based on a total of seven advanced generic and specialization electives. Where the seven courses are adopted from within a single specialization domain, the degree will be offered as **Bachelor of Science in Zoology (with name of specialization) i.e Bachelor of Science in Zoology (Fisheries and Aquaculture)** in accordance with the National Qualifications Framework (2015), and where the seven courses are adopted from more than one specialization domains, the degree will be awarded as **Bachelor of Science in Zoology** in its generic form and without any specialization.

2. Associate degree in Zoology

Associate degree in Zoology will be awarded after completion of four regular semesters over a period of two years and consist of 72 Credit hours. Associate degree in Zoology consists of General Education, Interdisciplinary and Major courses.

Eligibility and Admission Criteria

Higher Secondary School Certificate (involving 12 years of schooling) or an IBCC equivalent qualification in any science group with a subject of Biology or General Biology is the basic eligibility requirement for admission in the **Bachelor of Science in Zoology** and **Associate Degree in Zoology**. Minimum eligibility scores are 45% marks in the last attended certificate examination. The department/ University may conduct entry / admission test through its own testing body or an external testing services provider of repute as per the screening, admission and merit calculation criteria approved by its statutory bodies.



Program Structure

The Bachelor of Science in Zoology is structured in accordance with the provisions of the HEC Undergraduate Education Policy V 1.1. and comprises of minimum 140 credit hours (including supervised internship and capstone) spread over 8 regular semesters.

Summary of the Program	
Minimum Credit Hours	140
General Education	35 Credit Hours
Discipline Related Courses/ Major	72 Credit Hours 24 Courses
Interdisciplinary/ Allied Courses	27 Credit Hours 10 Courses
Internship	3 Credit Hours
Capstone	3 Credit Hours
Program Duration	Minimum: 4 years (8 regular semesters) Maximum: 6 years (12 regular semesters) The maximum limit is further extendable in accordance with HEC semester rules
Semester Duration	16-18 weeks for regular semesters (1-2 weeks for examination) 8-9 weeks for summer semesters (1 week for examination)
Course Load	15-18 credit hours for regular semesters Up-to 8 credit hours for summer semesters (for remedial/deficiency/failure/repetition courses only)
3 Credit Hours (Theory)	3 classes (1 hour each) OR 2 classes (1.5 hour each) OR 1 class (3 hours) per week throughout the semester
1 Credit Hours (Lab / Field Work)	1 credit hour in laboratory or practical work /project requires lab contact of 3 hours per week throughout the semester



Semester-wise Breakup

1st Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 111	Animal Diversity-I (Invertebrates)	3(2-1)
GE 111	Quantitative Reasoning-I	3 (3+0)
GE 112	Functional English	3 (3+0)
GE 113	Applications of Information & Communication Technologies	3 (2+1)
GE 114	Inorganic Chemistry	3 (2-1)
Anyone from the following		
GE 115	Islamic Studies	2 (2-0)
GE 116	Ethics	2 (2-0)
Anyone from the following		
GE 117	Fehm-e-Quran-I	1(0-1)
GE 118	Ethics: A General Introduction	1(0-1)
Total Credit Hours		18(14+4)

2nd Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 121	Animal Diversity-II (Chordates)	3 (2-1)
ZOO 122	Cell Biology	3 (2-1)
ZOO 123	Animal Form & Function-I	3(2-1)
GE 121	Quantitative Reasoning-II	3(3-0)
GE 122	Expository Writing	3(3-0)
GE 123	Social Sciences	2 (2-0)
Anyone from the following		
GE 124	Fehm-e-Quran-II	1(0-1)
GE 125	Cyber Ethics	1(0-1)
Total Credit Hours		18(14+4)

3rd Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 231	Ecology	3(2-1)
ZOO 232	Evolution	3(3-0)
ZOO 233	Animal Form & Function-II	3(2-1)
GE 231	Pakistan Studies	2(2-0)
GE 232	Civics and Community Engagement	2(2-0)
GE 233	Seerat-un-Nabi	1(0-1)
GE 234	Arts & Humanities	2(2-0)
GE 235	Entrepreneurship	2(2-0)
Total Credit Hours		18(15+3)



4th Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 241	Animal Behavior	3(3-0)
ZOO 242	Zoogeography & Paleontology	3(2-1)
ZOO 243	Developmental Biology	3(2-1)
GE 241	Ideology and Constitution of Pakistan	2(2-0)
IDS 241	Organic Chemistry	3(2-1)
IDS 242	Diversity of Plants	3(2-1)
Total Credit Hours		17(13+4)

5th Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 351	Ichthyology	3(2-1)
ZOO 352	Principles of Systematics	3(2-1)
ZOO 353	Entomology	3(2-1)
IDS 351	Principles of Genetics	3(2-1)
IDS 352	Plant Physiology	3(2-0)
IDS 353	Environmental Chemistry	3(3-0)
Total Credit Hours		18(14+4)

6th Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 361	Fisheries & Aquaculture	3(2-1)
ZOO 362	Research Methodologies and Bioethics	3(2-1)
ZOO 363	Ornithology	3(2-1)
ZOO 364	Parasitology	3(2-1)
IDS 361	Principles of Biochemistry	3 (2-1)
IDS 362	Biostatistics	3 (2-1)
Total Credit Hours		18(12+6)

7th Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 471	Wildlife Conservation & Management	3(2-1)
ZOO 472	Economic Zoology	3(2-1)
ZOO 473	Applied Entomology	3(2-1)
ZOO 474	Mammalogy	3(2-1)
IDS 471	Microbiology & Immunology	3(3-0)
INT 471	Internship	3(0-3)
Total Credit Hours		18(11+7)



8th Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 481	Wildlife of Pakistan	3(2-1)
ZOO 482	Parasitic Diseases in Animals and Human	3(2-1)
ZOO 483	Endocrinology	3(2-1)
IDS 481	Computational Biology	3(3-0)
CP 489	Capstone Project	3(0-3)
Total Credit Hours		15(9+6)

Total Cr. Hours:

140



Note: The course contents for General Courses and Interdisciplinary/Allied Courses will be available in separate documents, titled "General Courses Cluster" and "Interdisciplinary Courses Cluster" on the University of Chitral website.

GE 111	Quantitative Reasoning-I	3(3-0)
GE 112	Functional English	3(3-0)
GE 113	Applications of Information and Communication Technologies	3(2-1)
GE 114	Natural Sciences	3(3-0)
GE 115	Islamic Studies	2 (2-0)
GE 116	Ethics	2 (2-0)
GE 117	Fehm-e-Quran-I	1(0-1)
GE 118	Ethics: A General Introduction	1(0-1)

GE 121	Quantitative Reasoning-II	3(3-0)
GE 122	Expository Writing	3(3-0)
GE 123	Social Sciences	2(2-0)
GE 124	Fehm-e-Quran-II	1(0-1)
GE 125	Cyber Ethics	1(0-1)

GE 231	Pakistan Studies	2(2-0)
GE 232	Civics and Community Engagement	2(2-0)
GE 233	Seerat-un-Nabi	1(0-1)
GE 234	Arts & Humanities	2(2-0)
GE 235	Entrepreneurship	2(2-0)

GE 241	Ideology and Constitution of Pakistan	2(2-0)
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First Semester

1 st Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO 111	Animal Diversity-I (Invertebrates)	3(2-1)

ZOO 111 Animal Diversity-I (Invertebrates)

Credit Hours 3(2+1)

Course Description:

This course introduces students to the taxonomic characteristics and classification of invertebrates. The increasing complexity in organization and functions from protozoans to echinoderms is discussed. The evolutionary perspective of each phylum is described.

Course Learning Outcomes:

This course will be based on following outcomes:

1. Acquire the basic concepts of invertebrates with explanation of evolutionary origin and diversification.
2. Understand invertebrate organismal concepts in laboratory and field.
3. Demonstrate major evolutionary innovations for invertebrates with functional importance.
4. Understand how reproduction and development occurred
5. Analyze economic and ecological importance of invertebrates.

Course Contents:

1. INTRODUCTION

a. Classification of Organisms:

ANIMAL-LIKE PROTISTS: THE PROTOZOA

- a. General Characteristics.
- b. Classification up to class
- c. Symbiotic Lifestyles
- d. Locomotion in protozoa
- e. Nutrition and Reproduction.

MULTICELLULAR AND TISSUE LEVELS OF ORGANIZATION

Phylum Porifera

- a. Characteristics and classification. Cell Types, Body Wall, and Skeletons.
- b. types of canals system.
- c. Reproduction.

Phylum Cnidaria (Coelenterate)

- a. General Characteristics.
- b. Classification up to Class.
- c. The body Wall and Nematocysts
- d. Reproduction

Phylum Ctenophore.



- a. General Characteristics, body organization

THE TRIPLOBLASTIC ORGANIZATION PHYLUM

PLATYHELMINTHES (ACOELOMATE)

- a. General Characteristics.
- b. Classification up to class
- c. The Free-Living Flatworms and the Tapeworms

Phylum Nemertea.

General Characteristics

Phylum Gastrotricha

General Characteristics

PHYLUM ASCHELMINTHS (PSEUDOCOELOMATE)

- a. General Characteristics
- b. Classification up to class
- c. Characteristics of Phylum Rotifera and Phylum Kinorhyncha.

COELOMATIC ORGANIZATION

PHYLUM ANNELIDA

- a. General Characteristics
- b. Classification
- d. Locomotion, Feeding and the Digestive system, Gas Exchange and Circulation, Nervous and Sensory Functions, Excretion, Reproduction; Regeneration, Development, in Polychaeta, Oligochaeta and Hirudinea.

PHYLUM MOLLUSCA

- a. General Characteristics
- b. Classification up to class.
- c. Shell, Feeding, Digestion, Gas Exchange, Locomotion, d. Reproduction and Development of Gastropods, bivalves, and cephalopods

PHYLUM ARTHROPODA

- a. General Characteristics
- b. Classification up to class
- c. The Exoskeleton; Metamerism and Tagmatization
- d. Nutrition and digestive system
- e. Reproduction: Development, Metamorphosis; (class insecta), crustaceans and Arachnida.

PHYLUM ECHINODERMS

- a. General Characteristics
- b. Classification up to class.
- c. Maintenance Functions, Reproduction; Regeneration, Larval forms and phylogeny of class Asteroidea

Practical:

Note: Classification of each members of each phylum up to order with adaptations in relation to habitat of the specimen. Preserved Specimen and or colored projection slide and or CD ROM projection of computer must be used.



Study of Euglena, Amoeba, Entameba, Plasmodium, Trypanosome, Paramecium as representative of animals like Protists.

Study of prepared slides of sponges, spicules of sponges, and their various body forms. Study of representatives of classes of Phylum Porifera

Study of principal representatives of classes of Phylum Coelenterate.

Study of principal representatives of classes of Phylum Platyhelminthes.

Study of representatives of phylum Rotifer, Phylum Nematode.

Study of principal representatives of classes of Phylum Mollusca.

Study of principal representatives of classes of Phylum Annelida.

Study of principal representatives of classes of groups of Phylum Arthropoda

Study of representatives of classes of phylum Echinodermata.

Preparation of permanent mount of Leucosolenia, Obelia, Hydra, Proglottid of Tapeworm, Parapodia of Nereis and Daphnia. Drawing and labeling.

Preparation of permanent slide of mouthpart of insects (after dissection). Drawing and labeling.

How to make grade-wise series for preparation of temporary and permanent slides.

Recommended Principal Reference Book:

1. Miller, S. A., Harley, J. P., Aloï, J., & Erickson, G. (2002). Zoology. New York: McGraw-Hill.
2. Hickman, C.P., Roberts, L.C/, AND Larson, A., 2018. INTEGRATED PRINCIPLES OF ZOOLOGY, 15th Edition (International), Singapore: McGRAW-Hill.
3. Pechenik, J.A., 2015. BIOLOGY OF INVERTEBRATES, 7th Edition, (International), Singapore: McGraw-Hill.
4. Campbell, N.A., 2002; BIOLOGY 6th Edition, Menlo Park, California; Benjamin Cummings Publishing Company, Inc.

BOOKS FOR PRACTICAL

Miller, S.A., 2002. GENERAL ZOOLOGY LABORATORY MANUAL. 5th Edition International), Singapore: McGraw-Hill.

Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in integrated principal of zoology. Singapore: McGraw-Hill

GE 114 Inorganic Chemistry

Course Description

The course provides an overview of fundamental and important topics in inorganic chemistry: The structure of the atom, structure and bonding of molecules explained using the Lewis structure model, VSEPR theory, valence bond theory, and molecular orbital theory. Acids and bases, p-block elements. This course is designed to prepare zoology students to apply concepts of inorganic chemistry in the subject of zoology.

Credit Hours 3(2+1)

Course Contents

Chemical Bonding: Types of chemical bonding, ionic and covalent bonding, localized bond approach, theories of chemical bonding, valence bond theory (VBT), hybridization and resonance, prediction of molecular shapes using Valence Shell Electron Pair Repulsion



(VSEPR) model, molecular orbital theory (MOT) applied to diatomic molecules, delocalized approach to bonding, bonding in electron deficient compounds, hydrogen bonding.

Acids and Bases: Brief concepts of chemical equilibrium, acids and bases including soft and hard acids and bases (SHAB), concept of relative strength of acids and bases, significance of pH, pKa, pKb and buffer solutions, theory of indicators, solubility, solubility product, common ion effect and their industrial applications.

p-Block Elements: Physical and chemical properties of p-block elements with emphasis on some representative compounds, inter-halogens, pseudo-halogens and polyhalides.

Practical:

Lab safety and good laboratory practices, knowledge about material safety data sheets (MSD), disposal of chemical waste and first-aid practices, qualitative analysis of salt mixtures, quantitative analysis, acid- base titrations, preparation and standardization of acid and alkali solutions, redox titrations, preparation and standardization of potassium permanganate solution and its use for the determination of purity of commercial potassium oxalate or oxalic acid, preparation and standardization of sodium thiosulfate solution and its use in determination of copper in a given sample, gravimetric analysis, determination of barium in a given sample, determination of chloride in a given solution.

Recommended Books

1. Shriver, D. F., Atkins, P. W., Langford, C. H., Inorganic Chemistry, 2nd ed., Oxford University Press, (1994).
2. Cotton, F. A. and Wilkinson, G., Advanced Inorganic Chemistry, 6th ed., John-Wiley & Sons, New York, (2007).
3. Chaudhary S. U., Ilmi Textbook of Inorganic Chemistry, Ilmi Kitab Khana, Lahore, (2013).

Second Semester

ZOO 121 Animal Diversity-II (Chordates)

Credit Hours 3(2+1)

CourseDescription

This course is designed to enable students acquire the basic knowledge regarding the Taxonomic characteristics of chordates, their phylogenetic relationship and diversity of of the chordates. It presents a brief survey of Pisces, amphibians, reptiles and mammals. The course also focuses on the process of micro evolution within chordates.

Course Learning Outcomes

1. Students will be able to understand the Taxonomic characteristics of different chordates
2. Students will acquire knowledge about the phylogenetic relationships of various classes of chordates.
3. The students will develop critical thinking about phylogeny of chordates with respect to their physiological adaptations, behavior and ecology.

Course outline:

1. Protochordates

- a. Classification of protochordates
- b. Structure, anatomy and organ systems of Acorn worms, Urochordates and Cephalochordates
- c. Reproduction; life histories and metamorphosis of protochordates.

2. Fishes:



- a. Vertebrate Success in Water.
- b. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli
- c. General adaptations for locomotion, feeding and nutrition, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development.

3. Amphibians:

- A. The first terrestrial vertebrates.
- B. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura.
- C. Structure and locomotory adaptations, nutrition, gas exchange, temperature regulation, excretion
- D. Reproduction, development and metamorphosis of caudate, anura and Gymnophiona.

4. Reptiles:

- a. The First Amniotes and cladistic interpretation of the amniotic lineage. General characteristics of reptiles.
- b. Characteristics of Order Testudines or Chelonia, Rhynchocephalia, Squamata, and Crocodilia
- c. Adaptations in external structure and locomotion, nutrition, gas exchange and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development.

5. Birds:

- a. Classification, Feathers, flight and endothermy.
- b. Phylogenetic relationships; ancient birds and the evolution of flight.
- c. Diversity of modern birds.
- d. Adaptation in external structure and locomotion, nutrition, circulation, gas exchange, nervous and sensory systems, excretion and osmoregulation, reproduction, and development.

6. Mammals:

- a. Diversity and Classification, Characteristics of mammals: specialized teeth, endothermy, hair and viviparity.
- b. Adaptations in external structure and locomotion, nutrition and the digestive system, gas exchange
- C. temperature regulation, excretion and osmoregulation, behavior, reproduction, and development.

Practicals:

Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.

Visit PMNH for the study of the diversity of chordates.

Text and Reference Books:

- Hickman, C. P., Roberts, L. S., & Larson, A. (2003). Animal diversity. McGraw-Hill.
- Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
- Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.



- Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
- Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.

ZOO 122 Cell Biology

Credit Hours 3(2+1)

Course Description

This course is designed to help students understand basics of the cell structure and function at cellular and molecular level. In this course a detailed account of functional physiology of the cells will be discussed at molecular level. The course is divided into 7 different sections/chapters dealing with important components and aspects of cell biology. It offers both theoretical and practical understanding of cell in detail.

Course Learning Outcome

Upon completion of this course, students will be able to:

ACQUIRE the basic concepts of cell biology.

UNDERSTAND the metabolic processes of cells in terms of cellular organelles, membranes, and biological molecules

ABILITY to understand the role of macromolecules regulating cellular processes.

FORMULATE the critical thinking skills and knowledge on cell.

1. Introduction cell structure and function

- a. Cell theory b. Comparison of plant and animal cells
- c. Comparison of prokaryotic and eukaryotic cells

2. Cell membranes

- a. Structural models b. Chemical composition and function
- 3. Cell Organelles (structure and function) a. Endoplasmic reticulum b. Golgi Bodies c. Mitochondria d. Lysosomes e. Peroxisomes f. Ribosome

4. Nucleus

- a. Structure and function b. Nuclear membrane c. Chromatin

5. Cytoskeleton

- a. Structure and types b. Function of cytoskeleton

6. Cellular transport

- a. Diffusion and osmosis b. Facilitated and active transport
- c. Endocytosis and exocytosis

7. Cellular reproduction

- a. Cell cycle b. Mitosis c. Meiosis

Practical:

Microscopy

Staining techniques (Gram staining)

Identification of cell organelles (prepared slides)

Preparation of temporary whole mount.



Preparation of permanent whole mount.

Squash preparation of onion root tip for mitotic stages.

Study of mitotic and meiotic stages (prepared slides)

Books Recommended:

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D. 2017. Molecular Biology of the Cell. 6th Edition. Garland Publishing Inc., New York

2. Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin. 2016. Molecular Cell Biology. W. H. Freeman Publishers, Scientific American Inc.

3. Geoffrey M.C., Robert E.H. 2007. The cell: A Molecular Approach, Sinauer Associates, INC.

4. Karp, J. 2005. Cell and Molecular Biology, Concepts and Experiments, John Wiley and Sons, INC

5. De Robertis, E. D. P. 2017. Cell and Molecular Biology, 8th edition, Lea & Febiger, New York

ZOO 123 Animal Form and Function-I

Credit Hours 3(2+1)

Course Description

This course takes a comparative approach to investigate the physiology and anatomy of different animal organ systems. Students will be introduced to how body systems have evolved in different animal groups to become adapted to the environment, be it terrestrial or aquatic. The course will also prepare students for further studies in ecophysiology. The course will emphasize biological structures at the level of whole organisms and organs and their role in the survival and reproduction of individuals and the evolution of populations.

Course Learning Outcomes:

Upon completion of this course, students will be able to:

Acquire the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in the environments e.g., gills in aquatic and lungs in terrestrial environment.

Understand that diverse forms adapted to perform the same functions are because of the different past and present conditions.

Solve the emergence of diversity of forms for the performance of similar functions.

Analyze the requirements of diverse forms for the performance of similar functions in their past and present needs.

Evaluate the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.

Demonstrate that a form is successfully adapted to perform a function adequately and successfully.

Course Outline:

1. Protection, Support, and Movement:

a. Protection: the integumentary system of invertebrates and vertebrates.

b. Movement and support: the skeletal system of invertebrates and vertebrates.



c. Movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates

2. Communication I:

Neurons: Structure, function, and signal transmission.

Nervous Systems: Comparison of invertebrate and vertebrate systems (nerve cords, ganglia, brain, spinal cord, cranial/spinal nerves).

Autonomic Nervous System: Basic overview.

3. Communication II:

a. **Senses: Sensory reception:** baroreceptors, chemoreceptors, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates

b. **Lateral line system** and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air and water, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates

4. Communication III:

a. **The Endocrine System and Chemical Messengers:** Chemical messengers: hormones chemistry; and their feedback systems; Mechanisms of hormone actions, hormone receptors, signal transduction and hormonal coordination.

b. **Hormones** with principal function each of porifera, cnidarians, platyhelminthes, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals

5. Circulation and Immunity:

a. Internal transport and circulatory systems in invertebrates

b. Characteristics of invertebrate coelomic fluid, hemolymph, and blood cells

Practicals:

1. Study and notes of skeleton of Labeo (Labeorohita), Frog (Hoplobatrachustigerinus), Varanus (Varanus bengalensis), fowl (Gallus gallusdomesticus) and rabbit (Oryctolagus cuniculus).

2. Earthworm or leech; cockroach, freshwater mussel, Channa or Catlacatla or Labeo or any other local fish, frog, pigeon and rat or mouse and rabbits dissections as per availability.

3. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).

Books Recommended:

· Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw-Hill.

· Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Ed. (International), Singapore: McGraw-Hill.

· Miller, S.A. and Harley, J.B. 2002. Zoology, 5th Ed (International), Singapore: McGraw-Hill.



- Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing
- Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw-Hill.
- Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill.

Third Semester

ZOO 231 Ecology

Credit Hours 3(2+1)

Course Learning Outcome

- **Acquire** a comprehensive understanding of the fundamental concepts and principles of ecology, including ecosystem dynamics, biodiversity, and ecological interactions.
- **Understand** the theoretical knowledge to practical situations by conducting fieldwork, laboratory experiments, and data analysis related to ecology and conservation.
- **Solve** the impact of human activities on natural ecosystems, including habitat destruction, pollution, climate change, and resource exploitation, and propose strategies for mitigation and restoration.
- **Analyze** ecological data and scientific literature to assess the health and status of ecosystems, identify environmental problems, and propose evidence-based solutions.
- **Evaluate** current environmental policies, regulations, and management practices, and propose improvements based on scientific evidence and ethical considerations.
- **Demonstrate** a commitment to ethical and sustainable practices in environmental science, considering social, cultural, and economic factors in decision-making and advocating for environmental justice and equity.

Course Outline

1. Energy

- a. Basic Concepts of and Types of Ecology, ecological organization
- b. Laws of thermodynamics, primary and secondary productions
- c. Trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs.

2. Biogeochemical cycle:

- a. Nitrogen, Phosphorus, Sulphur, Water, Carbon and nutrient.

3. Limiting factors

- a. Basic Concepts, Temperature, Soil, Water and Humidity, Light and Fire.

4. Global ecosystems:



- a. Atmosphere, Hydrosphere, Lithosphere and Ecosphere.
- b. An overview of Ecosystem with special reference to Ecological Niche, basic concepts and types
- c. Major ecosystem of world, Forest, Grassland, Desert, Tundra and Agricultural ecosystems.
- d. Marine, Estuarine, Freshwater and Wetlands

5. Population ecology

Basic population characters, Growth and Growth Curves, Population Dynamics and Regulations.

6. Community ecology

Basic concepts, Community Analysis, Ecotones, Inter-population Interactions

7. Applied Ecology: resources and their ecological management;

Mineral, Agricultural Desalination, Weather Modification, Forest and Range Management, Landscape and Land use

8. Exotic and Invasive Species

- a. Desertification, Deforestation, exotic and invasive species

Practicals

Population Sampling Techniques (Quadrat, Line Transact, Point count, Focal Scan and Capture and Recapture Method).

Study of different Ecosystems (Fresh Water, Terrestrial, Marine /Mountain/ Desert).

Ecological Notes.

Measurements of physical Factors of different Ecosystems.

Adaptive features of animals in relation to food and environment.

Food chain studies through analysis of gut contents.

Analysis of polluted and fresh water for biotic and abiotic variations.

Field visits for study of selected terrestrial habitat and writing notes

Experimental design and approaches in ecological research; writing a research project

Development of an ecological management plan of some selected area

Recommended Book

Molles, M.C. 2005. Ecology: Concepts and Applications. 6th Ed., McGraw Hill, New York, USA

Cox, C.B., Morre, D. 2000. Biogeography: An Ecological and Evolutionary Approach, 6th Ed., Life Sciences King's College, London, UK.

Dondson, S.I., Allen, T.F.N., Carpenter, S.R., Ives, A., Jeanne, R.L., Kitchell, J.F., Langston, N.E., Turner, M.G. 1998. Ecology. Oxford Univ. Press, UK.



Chapman, J.L., Reiss, M.J. 1997. Ecology: Principles and Applications. Cambridge Univ. Press, UK.

Odum, E. P. 1994. Fundamentals of Ecology. 3rd Ed. W.B. Saunders. Philadelphia.

Newman, I. 1993. Applied Ecology. Black Well Scientific Publications Oxford UK.

Slingsby, D., Cook, C., 1986. Practical Ecology. McMillan Education Ltd.

ZOO 232 Evolution

Credit Hours 3(3+0)

Course Description

This course provides a comprehensive exploration of evolutionary biology, tracing the development of the theory from its historical roots in the work of Lamarck, Darwin, and Wallace to the modern synthetic understanding. Students will investigate the core mechanisms of evolution, including the modern concept of natural selection (using the VISTA framework), genetic drift, and gene flow, which drive both microevolution and macroevolution. By examining evidence from paleontology, anatomy, and molecular biology, the course offers a holistic view of life's history, from major transitions like the evolution of multicellularity to specific evolutionary trends.

Course Learning Outcomes:

1. To acquire basic knowledge for the factors and theories related to the origin of life.
2. To understand the vital concepts proposed by various scientists for the appearance of life on earth.
3. To understand the evolutionary history of major animal phylas, evolutionary events and major transitions.
4. To solve the critical issues for the discrepancies based on origin of life.
5. To analyze certain issues regarding the animal phyla, classes, orders till sub-species levels.

Course Contents

Module 1: Introduction, Historical Perspectives & Evidences

- a) Brief introduction to evolution, importance of evolution in biology
- b) Historical theories: pre-Darwinian ideas
- c) Theory of Charles Darwin and Alfred Russel Wallace
- d) Lamarckism
- e) Darwinism
- f) Modern synthetic theory (Neo-Darwinism)
- g) Evidence for Evolution: Embryological, Anatomical, Molecular & Biochemical, and Paleontological evidence.

Module 2: Modern concept of Natural Selection

- a) Natural selection, components of Natural Selection; VISTA: Variation and Inheritance, Survival, Time and Adaptation
- b) Types of selections: Directional, stabilizing, and disruptive.
- c) Levels of selection: Genic, Individual, Group and Species selection,



- d) Examples of natural selection in the field and experiment

Module 4: Microevolution and Macroevolution:

- a) Microevolution: factors initiating elementary evolutionary changes; mutations, immigration, crossbreeding, genetic drift, non-random mating.
- b) Macroevolution: Role of Isolation, regression, immigration, crossbreeding, Adaptive radiations in evolution.
- c) Convergence and Divergence evolution

Module 5: Major Transitions and Speciation

- a) Overview of major transitions.
- b) Evolution of Eukaryotic cell.
- c) Evolution of Multicellularity.
- d) Evolution of Individuality.
- e) Solitary to group living.
- f) Evolution of Man and Horse
- g) Speciation, allopatric, sympatric, peripatric and parapatric speciation

Module 6: Extinctions and Evolutionary Trends

- a) The concept of extinction.
- b) Background extinction.
- c) Mass extinction.
- d) Factors correlated with extinction.
- e) Mimicry: Batesian mimicry, Mullerian mimicry, Allometry

Text and Reference Books:

1. Bergstorm C.T and Duagtkin L.A. 2016. Evolution. ISBN 9780393937930. W. W. Norton & Company, Inc., 500 Fifth Avenue, New York, NY 10110-0017.
2. Strickberger. M.W.2012. Evolution. Jones & Barrett Publishers. Gower Street, London, England
3. Ridley, M. 1993. Evolution. Blackwell Scientific Publications, New York, USA
4. Moody, P.A. 1989. Introduction to Evolution, Harper and Row, Publishers, NewYork
5. Wiley, E. O. and Lieberman, B. S. 2011. Phylogenetics: Theory and Practical Practice of Phylogenetic Systematics. 2nd Ed. Wiley-Blackwell

ZOO 233 Animal Form & Function-II

Credit Hours 3(2+1)

Course Description

In this course students will learn about animal form and function. What kind of strategies animal uses to get their food? The course takes a comparative approach to investigate the physiology and anatomy of different animal organ systems. Students will be introduced to how body systems have evolved in different animal groups to become adapted to the environment, be it terrestrial or aquatic. You will carry out experiments to explore how different systems function e.g., respiration digestion and reproduction. The course will also prepare students for further study in ecophysiology

Course Learning Outcomes

Upon completion of this course, students will be able to:



Acquire the concept that for the performance of a function for example exchange of respiratory gases the different forms are adapted in t environments e.g., gills in aquatic and lungs in terrestrial environment.

Understand that diverse forms adapted to perform the same functions are because of the different past and present conditions.

Solve the emergence of diversity of forms for the performance of similar function.

Analyse the requirements of diverse forms for the performance of similar function in their past and present needs.

Evaluate the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.

Demonstrate that a form is successfully adapted to perform a function adequately and successfully.

Course Outline:

1. Nutrition and Digestion:

- Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion
- Animal strategies for getting and using food, diversity in digestive structures of invertebrates.
- 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.

2. Transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response

3. 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 Systems: How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions. Reproduction and Development

4. Reproduction:

- Asexual reproduction in invertebrates; advantages and disadvantages 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.

Practicals:



- o Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
 - o Study of excretory systems in an invertebrate and a vertebrate representative (Model).
 - o Study of dissection systems in invertebrates and a vertebrate representative (Dissection).
- Dissection and study of male and female reproductive system in vertebrates and invertebrates
Note: Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used.

Books Recommended

- Pechenik, J.A. 2013. Biology of Invertebrates, 4th Ed. (International), Singapore: McGraw-Hill.
- Hickman, C.P., Roberts, L.S., Larson, A. 2004. Integrated Principles of Zoology, 11th Ed. (International), Singapore: McGraw-Hill.
- Miller, S.A., Harley, J.B. 2002. Zoology, 5th Ed. (International), Singapore: McGraw-Hill.
- Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin / Cummings Publishing Company, Inc.
- Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw-Hill.
- Hickman, C.P., Kats, H.L. 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw-Hill

Fourth Semester

ZOO 241 Animal Behavior

Credit Hours 3(3+0)

Course Description

This course explores the fascinating world of animal behavior, providing students with a comprehensive understanding of how animals respond to external stimuli and the underlying mechanisms driving these responses. Students will delve into both classical and contemporary concepts of behavioral mechanisms, gaining insights into the physiological, neural, and genetic bases of behavior. Through the study of various animal species, students will learn about the development of behavior, from innate to learned behaviors, and how these behaviors adapt to environmental changes.

Course Learning Outcomes:

Upon completion of this course, students will be able to:

Acquire a comprehensive understanding of the various types of animal behavior and the factors influencing them, including proximate and ultimate causes.

Understand the development of behavior in animals, including the role of neural and physiological mechanisms, as well as the impact of external and internal stimuli.

Solve problems related to animal behavior by applying knowledge of innate and learned behaviors, as well as cognitive processes, to real-world scenarios.

Analyze the ecological and genetic influences on animal behavior, including the concept of territoriality, circadian rhythms, and the costs and benefits of certain behaviors.



Evaluate the social organization and communication strategies of animals, including the concepts of altruism, competition, and social structures in different species.

Demonstrate proficiency in observing, recording, and interpreting animal behavior through practical exercises, case studies, and field observations.

Course Outline

1. Introduction to Animal Behavior
 - 1.1 Introduction, Ethology, Classical Ethology, Anthropomorphism
 - 1.2 The four levels of analysis: Proximate and ultimate causes of behavior.
 - 1.3 Foundations of Animal Behavior:
 - a) Natural Selection,
 - b) Individual Learning and
 - c) Cultural Transmission
 - 1.4 Approaches to study of animal behavior: Conceptual, theoretical and empirical
2. Development of behavior:
 - 2.1 Role of external and internal stimuli and animal responses
 - 2.2 Neural and Physiological mechanisms (hormones) of behavior.
 - 2.3 Role of genes, molecular genetics, development, and maturation
3. Types of Behavior:

Innate behavior, and innate releasing mechanisms with examples

 - 3.1 Learned behavior,
 - 3.2 Types of learning and its mechanisms, quick learners' vs slow learners.
 - 3.3 Complex behaviors and decision-making key to understand and develop multiple behavioral choices.
4. Circadian rhythms
 - 4.1 Biological Rhythms and concept of bio-rhythmicity in animals.
 - 4.2 Types of circadian rhythms
 - 4.3 Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities.
 - 4.4 Migration
5. Sociobiology and social behaviors
 - 5.1 Social organization in animals and group living; benefits and costs of group living.
 - 5.2 Social organization in insects and mammals.
 - 5.3 Aggression, Dominance Hierarchies, Appeasement,
 - 5.4 Cooperation,
 - 5.5 Kinship, Altruism, Hamilton Rule, Territoriality,
6. Foraging and Anti-Predatory behavior:
 - 6.1 Finding food, optimal foraging theory
 - 6.2 Successful foragers and winners of predator-prey relationships.
 - 6.3 Foraging and Predation trade-off



- 6.4 Predator avoidance behavior in different animals,
7. Reproductive Behaviors:
 - 7.1 Sexual Selection; Cost and benefits of sexual reproduction,
 - 7.2 Inter and Intra sexual selection, Sexual Conflicts
 - 7.3 Mating Systems
 - (a) Monogamous (b) Polygamous: Polyandrous and Polygynous
 - 7.4 Parental Care; Types
 - 7.5 Parental care in Fishes, Amphibians, Reptiles, Birds and Mammals
8. Communication in animals:
 - 8.1 Communication, Signals, Channel and Medium
 - 8.2 Various types of communication; Auditory, chemical, visual, tactile, bioacoustics, electrical
 - 8.3 Various types of chemical signals in animals' behavior and their importance in ecosystems.
 - 8.4 Evolution of signals
 - 8.5 Reliability of signals

TEXT AND REFERENCE BOOKS:

- Dngatkin, L. A. 2012. Principles of Animal Behavior. W.W. Norton and Co. New York.
- Nordell, S.E. and Valone, T.J. 2017. Animal Behavior. Concepts, Methods, and Applications. Second edition. ISBN 978-0-19-027674-4
- Alcock, J. 2010. Animal behavior, an evolutionary approach. 9th Edition. Sinauer Publishers.
- Barnard, C. J. (2004). Animal behaviour: mechanism, development, function and evolution. Pearson Education.

ZOO 242 Zoogeography and Paleontology

Credit Hours 3(2+1)

Course Description

This course explores the distribution of animals across the globe tracing their journeys from the distant past to the present day. Students will investigate how the dynamic history of Earth, including continental drift and the formation of biogeographic regions, has shaped modern and ancient animal distributions. The paleontology component provides a foundation in geological principles, fossilization, and the interpretation of the fossil record, using the geological time scale to trace the history of life from the Precambrian to the present. The course integrates concepts like geochronometry (radiometric dating) and biostratigraphy to understand evolutionary patterns, with a specific focus on the faunas and paleontologically significant areas of Pakistan.

Course Learning Outcomes

1. Describe the zoogeographical distribution of animals and processes involved in the fossilization of animals.
2. Illustrate the association of animals present to their past through fossils record.



3. Develop the understanding of speciation, dispersal isolation and extinction process through biogeography and fossils record.
4. Illustrate the ability to locate, characterize and differentiate various biomes and fossils of animals over time.
5. Explain the distribution of animals on the basis of fossils record.
6. Develop understanding regarding process of fossilization and its importance in evolutionary history of an animal and its distribution

Course Contents

1. Paleo geography

- a. Theories of continental drift and plate tectonics b. Pangea

2. Animal distribution

- a. cosmopolitan distribution
- b. discontinuous distribution
- c. isolation distribution
- d. bipolar distribution
- e. endemic distribution
- f. barriers and dispersal.

3. Zoogeographical regions:

- a. Zoogeographic Division and Boundaries
- b. Geographic Ranges, Physical Features

Climates, Faunas And Affinities of Palaearctic, Nearctic Regions, Oriental, Ethiopian, Australian, And Neotropical Regions

4. Paleontology:

- a. History, age, shells of earth
- b. atmosphere, hydrosphere, biosphere and lithosphere.
- c. Types; Igneous rocks, sedimentary rocks and metamorphic rocks.
- d. Fossil types and uses of fossils, nature of fossils.
- e. Fossilization
- f. Invertebrates and Vertebrates Fossil
- g. Biostratigraphy
- h. Fossils of Pakistan
- i. Paleontologically important areas of Pakistan.
- j. Geological time scale.
- k. Pre-Cambrian life.
- l. Post Cambrian life,
- m. Paleozoic life
- n. Mesozoic life

05. Geochronometry:

- a. Uranium/Lead dating
- b. radiocarbon dating, methods, index fossils
- c. Paleoecology, Paleomagnetism.

Practical:



1. Study of fauna of various zoogeographical regions.
2. Study of mould, cast, pseudomorph, coprolite, petrified fossils of plants and animals.
3. Study of invertebrate fossils of coelenterates, trilobites, ammonite, brachiopods, molluscs and echinoderms.
4. Study of vertebrate fossils e.g. horse/elephant/camel/bovids.
5. Study and identification of Igneous, Sedimentary and Metamorphic rocks
6. Map work for identification of various zoogeographical regions of the World.

Recommended Books

- Ø Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
- Ø Beddard, F. E. 2008. A text book of zoogeography. Bibliobazar, LLC.
- Ø Brouwer, A. 1977. General Palaeontology, Oliver and Boyd, London.
- Ø Darlington, P. J. Jr. 1963. Zoogeography, John Wiley and Sons
- Ø Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H. Freeman & Co. USA.
- Ø Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
- Ø Tiwari, S.K. 2006. Fundamentals of world zoogeography. Wedams eBooks Ltd (India) Sarup& Sons. Delhi.

ZOO 243 Developmental Biology

Credit Hours 3(2+1)

Course Learning Outcomes

Upon successful completion of the course, the student will be able to:

1. Gain familiarity with features that make an organism model for the learning of developmental biology e.g., fertilization in sea urchin with mammalian like mechanisms.
2. Apprehend the contributions of the sperm and the egg to form zygote
3. Elucidate the problems associated with cell differentiation through fate mapping.
4. Arrange and investigate the classical and modern experiments into “find it”, “block it”, and “move it” categories
5. Assess the set of experiments that will establish whether a planned aspect is both necessary and ample to cause a developmental episode
6. Demonstrate the ability to label macromeres, mesomeres, and micromeres and know which cell types are derived from each of these cell layers in the early embryo (e.g., primary and secondary mesenchyme, ectoderm, endoderm, and mesoderm)

Course Outlines

1. Introduction



- a. History and Basic Concepts of developmental biology
- b. Principal features of developmental biology and embryology with special emphasis on vertebrate models

Origin of sexual reproduction

Developmental patterns

2. Spermatogenesis

Mammalian spermatogenesis as model for all vertebrates Spermiogenesis or (spermateliosis)

The role of Sertoli and Leydig cells in spermatogenesis Hormonal control of spermatogenesis

Primates Menstrual cycle

3. Oogenesis

a. Mechanism of oogenesis among various classes of vertebrates.

b. Vitellogenesis

Hormonal control of Vitellogenesis and oogenesis

4. Fertilization

a. External & Internal Fertilization

b. Species-specific recognition of sperm and egg

c. Fusion of male and female gametes

d. Polyspermy: slow and fast blocks to polyspermy

e. Activation of egg metabolism

5. IN VITRO Fertilization (IVF)

a. History, Steps and advantages of IVF

b. Disadvantages and risk factors

6. Cleavage & Blastulation

a. Patterns of embryonic cleavage and blastulation among different vertebrate classes b.

Mechanism of cleavage.

7. GASTRULATION

a. Fate maps

b. Gastrulation in amphibians, birds and mammals

8. Early Vertebrate Development

a. Neurulation, ectoderm, mesoderm and endoderm formation

9. Placenta and extraembryonic membranes

10. Cellular Basis of Morphogenesis

a. Differential cell affinity, cell adhesion molecules

b. Organogenesis

c. Mechanism of teratogenesis

11. Aging and Regeneration in vertebrates

Practical:

Study of the structure of gametes in some representative cases, i.e. frog, fish and mammal.

Hen's egg internal and external structural details

Microscopic analysis of hen's egg yolk, albumin and shell membranes



Study of cleavage and subsequent development from prepared slides and/or models in various animals i.e., frog, mammals and chick etc.

Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.

Study of developmental stages of nematodes through microscopic analysis of animal dung

Semen analysis

Dactylography and its uses in developmental biology

Recommended Books

- Ø Gilbert, S. F. 2013. Developmental Biology, Sinauer Associates, Sunderland, MA.
- Ø Klaus, K. 2001. Biological Development. 2nd Ed., McGraw-Hill.
- Ø Scott F. Gilbert and Michael J.F. Barres. 2016. Developmental Biology. Sinauer Associates, Sunderland, MA.
- Ø Jamie. A. Davies. 2014. Life Unfolding: How the Human Body Creates Itself. Oxford University Press, USA
- Ø Balinsky, B. I. 1985. An Introduction to Embryology, Saunders.
- Ø Oppenheimer, S.S. 1984. Introduction to Embryonic Development, Allen and Bacon.
- Ø Saunders, J. W. 1982. Developmental Biology, McMillan and company.
- Ø Ham, R. G., Veomett, M. J. 1980. Mechanism of Development. C. V. Mosby Co.

IDS 241 Organic Chemistry

Credit Hours 3(2+1)

Course Learning Outcomes

Upon completion of the Course the student will be able to

1. To understand structure of different organic compounds
2. To understand different type of chemical bonding
3. To understand different chemical reactions between organic compounds
4. Draw structure of different organic compounds
5. Students will be able to differentiate between different organic groups

Course Outline

Basic Concepts of Organic Chemistry:

Bonding and hybridization, localized and delocalized bonding, structure aromaticity, inductive effect, dipole moment, resonance and its rules, hyperconjugation, classification and nomenclature of organic compounds including IUPAC system, types of organic reactions (an overview).

Chemistry of Hydrocarbons: Saturated, unsaturated and aromatic hydrocarbons with emphasis on synthesis and free radical, electrophilic addition and electrophilic substitution reactions.

Chemistry of Functional Groups: Hydroxyl, ether and amino groups, preparation and properties of alcohols, phenols, ethers, and amines with focus on reaction mechanism and applications, carbonyl compounds, preparations and reaction mechanism of aldehydes and ketones and their applications, carboxylic acids and their derivatives, acidity of carboxylic



acids and effect of substituents on their acidity, preparation and reactions of carboxylic acids and their derivatives including esters, amides, acid halides and acid anhydrides.

Practical:

Qualitative analysis of compounds with different functional groups, synthesis of organic compounds using as a tool for understanding techniques like reflux, distillation, filtration, recrystallization, and yield calculation, organic syntheses may include preparation of benzanilide from benzoyl chloride, succinic anhydride from succinic acid, phthalimide from phthalic anhydride, oximes and hydrazones from carbonyl compounds, and an ester from a carboxylic acid and alcohol etc.

Recommended Books

1. Brown, W. and Poon, T., Introduction to Organic Chemistry, 3rd ed., John-Wiley & Sons, Inc., (2005).
2. John, E. M. Organic Chemistry, 8th ed., Brooks/Cole Publishing Co, USA, (2012).
3. Robert, T. M. and Robert, N. B., Organic Chemistry, 6th ed., Prentice Hall, New Jersey, (1992).
4. Younus, M., A Textbook of Organic Chemistry, Ilmi Kitab Khana, Urdu Bazar, Lahore, Pakistan, (2006).

IDS 242 Diversity of Plants

Credit Hours 3(2+1)

Course Outline:

Comparative study of life form, structure, reproduction and economic significance of:

- a) Viruses (RNA and DNA types) with special reference to TMV;
- b) Bacteria and Cyanobacteria
- c) Algae (Chlamydomonas, Chara)
- d) Fungi (Penicillium, Puccinia, Agaricus)
- e) Lichens
- f) Bryophytes
 - i. Funaria
- g) Pteridophytes.
- h) Gymnosperms
- i) Angiosperms
 - i. Monocot
 - ii. Dicot

Lab Outline:

Culturing, maintenance, preservation and staining of microorganisms. Study of morphology and reproductive structures of the types mentioned in theory. Identification of various types mentioned from prepared slides and fresh collections.

Recommended Books:

1. Lee, R. E. 1999. Phycology. Cambridge University Press, UK
2. Prescott, L. M., Harley, J. P. and Klein, A. D. 2004. Microbiology, 3rd Ed. W.M. C. Brown Publishers.
3. Alexopoulos, C. J., Mims, C. W. and Blackwell, M. 1996. Introductory Mycology. 4th Ed. John Wiley and Sons Publishers



Fifth Semester

ZOO 351 Ichthyology

Credit Hours 3(2+1)

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

1. Classify the most important commercial fish species.
2. UNDERSTAND the concepts of basic internal and external morphology and physiology.
3. SOLVE the challenges in field of fish taxonomy and providing them concept of latest keys of identification.
4. ANALYZE the morphological and taxonomical features of various species.
5. EVALUATE the problems in identification of fishes.
6. DEMONSTRATE Fishes should be dissected to show all the key features in identifying the fishes and also show all the external and internal organs for better understanding.

Course Contents:

I. Fish, Animals, and Humans

- What Are Fish?
- Fish as Ancestors to Humans
- Habitats of Fish
- Life Processes in Fish
- Importance and Methods of Studying Fish
- Career Opportunities in Ichthyology

II. Foods, Digestion, Nutrition, and Growth

- Natural Diet of Fishes
- Feeding Behaviors
- Digestion, Absorption, and Nutrient Utilization
- Nutritional Requirements of Fishes
- Growth Patterns and Factors Affecting Growth

III. Skeleton, Body Structure, and Movement

- Skeletal System of Fish
- Locomotion Mechanisms
- Body Form and Its Role in Movement
- Function of Fins in Locomotion
- Myomeres and Swimming Dynamics
- Swimming Techniques
- Migration Patterns

IV. Blood and Circulatory System

- Heart and Circulatory Vessels



- Blood, Tissue Fluids, and Hematopoietic Organs
- Regulation of Body Temperature

V. Respiration

- Gill Structure and Function
- Role of Blood in Gas Transport
- Air-Breathing Adaptations in Fish
- Function and Physiology of the Gas Bladder

VI. Excretion and Osmoregulation

- Osmoregulatory and Excretory Organs
- Endocrine Regulation of Excretion and Osmoregulation

VII. Reproduction

- Modes of Reproduction
- Anatomy of the Reproductive System
- Sexual Dimorphism
- Breeding Behavior
- Egg Care and Yolk Utilization

VIII. Integration of Systems

- Role of Nervous and Endocrine Systems
- Structure and Function of the Nervous System
- Spinal Cord and Nerves
- Autonomic Nervous System
- Endocrine Organs and Their Functions

IX. Practical Work

1. Collection and Identification of Freshwater and Marine Fish Species
2. Dissection of Fish to Study Anatomical Features:
 - Reproductive System
 - Digestive System
 - Respiratory System
 - Circulatory System

Books Recommended:

1. Lagler, K.F., J.E. Baradach and R.R. Miller. 2009. Ichthyology. John Wiley and Sons, Inc., New York, USA.
2. Moyle, P.B. and J.J. Cech. 2008. Fishes: An Introduction to Ichthyology. 6th Ed. Prentice Hall, New Jersey, USA.
3. David, H. 2003. The Physiology of Fishes 3rd Ed. CRC Press, UK.

ZOO 352 Principles of Systematics

Credit Hours 3(2+1)

Course Description:

Systematics is an ever-changing discipline that examines the diversity of organisms, their genealogical relationships, and pattern of evolution. Thus, it constitutes the underlying basis



for organizing our knowledge of modern biology. This course provides a comprehensive survey of the theory and methods of systematics, focusing on modern methods of phylogenetics.

Course Learning Outcomes

1. Acquire the basic knowledge of contribution of taxonomy in biology
2. Provide in-depth knowledge of taxonomy in animal sciences
3. Develop concepts about importance of the taxonomy.
4. Study the history of taxonomy with basic rules
5. Demonstrate about identifications and naming of the organisms according to international code of zoological nomenclature

Course Contents:

Introduction

Taxonomy, Systematics, Levels of taxonomy: Alpha, Beta & Gamma taxonomy
Importance and applications of systematics; Contribution of systematic to Biology
Taxonomy in Animal science, systematics as a profession and its future perspectives.

History of taxonomy: Downward Classification and Upward Classification, Major developments in taxonomy, Future of Taxonomy; School of thoughts in Taxonomy

Basic terminologies of systematics, Theories of biological classifications, Micro and Macro taxonomy, taxonomic categories: specific category, intraspecific category, higher categories; Concept of taxon, category, phenon, morph and sibling species

Species concept:

Typological, Nominalist species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation,

Taxonomic characters:

Kinds and weightage, High and Low Weight Characters, Type of characters,

Taxonomic procedures and collections:

Taxonomic problem and the pre-requisite of collection; Methods of collection and their preservation. Curation; cataloguing and storage, duration,

Systematics Publications:

Features of taxonomic publications; Catalogue, Monographs, Checklists, Atlas, Faunal Work, Keys; types and merit demerits, Illustrations, Some online taxonomic resources.

Rules of Zoological Nomenclature:

ICZN, interpretation, application of important rules, Principles of ICZN, law of priority and validity of names.

Practical:

Study of preserved invertebrate species and their classification up to class level.

Collection, preservation and identification of common species with the help of keys

Preparation of keys for the identification of specimens

Methods of statistical analysis of samples from populations T-test, Analysis of variance etc.

Books Recommended:

- Wiley, E.O. and Lieberman, B. S. 2011. Phylogenetics: Theory and practice of phylogenetic systematics. 2nd Ed. Wiley-Blackwell. Hill, New York



Wheeler, W. C. (2012). Systematics: a course of lectures. John Wiley & Sons.
Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw-Hill, New York

Heywood, V.H. Taxonomy and Ecology. 1975. Academic Press, London

Research Articles

1. Padial, J. M., Miralles, A., De la Riva, I., & Vences, M. (2010). The integrative future of taxonomy. *Frontiers in zoology*, 7(1), 16.
2. COLEMAN, C. O., & RADULOVICI, A. E. (2020). Challenges for the future of taxonomy: talents, databases and knowledge growth. *Megataxa*, 1(1), 28-34.

ZOO 353 Entomology

Credit Hours 3 (2+1)

Course Learning Outcomes

After successful completion of the course the students will learn

1. To classify and identify the insects and major pests damaging to the crops.
2. Understand the basic knowledge about pest of economic importance
3. Understand methods of population estimation of the pest.
4. Become aware of the applications of different control strategies.

Course Outline:

Morphology and Physiology

- a. An introduction of Entomology.
- b. Complete morphology of an insect.
- c. Anatomy and Physiology of various systems with special reference to digestive, nervous, circulatory, respiratory, excretory and reproductive system.
- d. Development and metamorphosis.
- e. Hibernation and diapause.

Classification of insect orders:

- a. General account of apterygota
- b. Subclass: Apterygota
- c. Order Collembola
- d. Order Diplura
- e. Order Zygentoma
- f. Order Protura
- g. Order: Archaeognatha

Subclass: Exopterygota

- a. Order Dermaptera
- b. Order Dictyoptera
- c. Order Embiidina
- d. Order Neuroptera
- e. Order Strepsiptera
- f. Order Mantophasmatodea
- g. Order Mecoptera



- h. Order Orthoptera
- i. Order Phasmatodea
- j. Order Phthiraptera
- k. Order Plecoptera
- l. Order Psocoptera
- m. Order Siphonaptera
- n. Order Zoraptera
- o. Order Megaloptera
- p. Order Raphidioptera
- q. Order Ephemeroptera
- r. Order Odonata

Endopterygota

- a. Order Megaloptera
- b. Order Hymenoptera
- c. Order Coleoptera
- d. Order Lepidoptera
- e. Order Trichoptera
- f. Order Siphonaptera
- g. Order Diptera
- h. Order Neuroptera
- i. Order Mecoptera
- j. Order Raphidioptera
- k. Order Strepsiptera

Practical:

- a. Field visits for collection of different developmental stages of insects belonging to different orders.
- b. Identification and classification of collected specimens.
- c. Field visits and report writing of insect fauna of different crops.
- d. Field visits for survey of different control strategies being practiced for control of insect pests.
- e. Museum visits

Text and Reference Books:

- Ø Atwal, A.S., 2015. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
- Ø Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
- Ø Chapman, R. F., 2013. The Insects-Structure and Function. 5th Edition. Cambridge University Press, New York.
- Ø Gullan, P. J. and Cranstan, P. S., 2014. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.

IDS 351 Principles of Genetics

Credit Hours 3(2+1)

Course Description



This core second-year biology course examines patterns of inheritance, genes, and gene functioning from DNA to phenotype. Mendelian patterns of inheritance and exceptions will be discussed and expanded on from introductory courses in the previous semesters. Current topics in molecular techniques, transmission, stem cells, and ethics will also be discussed. Lab exercises will focus on basic quantitative techniques of analysing genetic frequencies and basic methodology in conducting genetic experiments, as well as practise employing rigid scientific process.

Course Learning Outcomes

After Successful Completion of the Course the students will be able to:

1. ACQUIRE the basic knowledge of simple Mendelian principals and pedigree construction.
2. UNDERSTAND the key features involved in different mode of transmission.
3. SOLVE the problem by pedigree construction and evaluation
4. ANALYZE the pedigree and predict the mode of inheritance of any genetic disorders
Able to define terms of genetics and apply concepts of modern transmissio
5. Solve transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes.
6. Describe the processes of gene regulation and predict how a gene will be expressed under specific circumstances.

Course Contents:

1. Introduction to Genetics

- a. Introduction, history and applications of Genetics,
- b. Gene as the Unit of Inheritance, The Gene Concept:
- c. Classical vs. Modern Perspectives, Forward and Reverse Genetic Approaches.

2. Transmission Genetic Analysis

- a. Mendel's Principles: Monohybrid and Dihybrid Crosses
- b. Beyond Mendel's laws: Incomplete dominance, co-dominance (e.g., ABO blood groups -Multiple Alleles), Gene Interactions: Epistasis, Lethality, and Pleiotropy

3. Chromosomal Basis of Inheritance

- a. The Chromosomal Theory of Inheritance
- b. Sex Determination Systems in Animals and Humans
- c. Sex-Linked, Sex-Influenced, and Sex-Limited Traits (e.g., Hemophilia, color blindness),
- d. Pedigree analysis

4. Genetic Linkage and Mapping

- a. Linkage and Recombination
- b. Chromosome Mapping using recombination frequency

5. Cytogenetics

- a. Changes in Chromosome Number: Aneuploidy, Euploidy and polyploidy (e.g., Down, Turner, Klinefelter Syndromes)
- b. Structural Chromosomal Aberrations: Deletions, Duplications, Inversions, Translocations



c. Human Karyotyping

6. Gene Regulation

- a. Regulation of Gene Expression in Prokaryotes (lac operon, trp operon, ara operon)
- b. Regulation of Gene Expression in Eukaryotes (Transcription factors, enhancers, silencers,
- c. DNA methylation, histone modification)

7. Medical Genetics and Genetic Counseling

- a. Single-Gene Disorders (e.g., Sickle Cell Anemia, Phenylketonuria)
- b. Polygenic and Multifactorial Inheritance (e.g., Cleft Lip/Palate)
- c. Prenatal Diagnosis: Amniocentesis and Chorionic Villus Sampling
- d. Genetic Counseling

8. Eugenics and Euthenics

9. Inbreeding and Heterosis

Practical:

1. Drosophila culture techniques: preparation and maintenance of culture
2. Identification of male and female fruit fly and isolation of virgin females
3. Study of polytene chromosomes from the salivary glands of Drosophila melanogaster
4. Mutation induction in Drosophila
5. Human karyotyping from photographs prepared slides: paper cut out method
6. Preparation of human metaphase chromosomes from blood lymphocytes
7. Study of mitosis in plants by using onion root tip cells
8. Study of meiosis in the testes of male grasshopper
9. Extraction of genomic DNA from whole blood (lymphocytes)
10. Separation of heterogeneous population of bio-molecules through electrophoresis
11. Study of blood group polymorphisms in local population
12. Study of qualitative traits in humans: a survey of common physical heritable (monogenic) polymorphisms
13. Human Pedigree analysis problems (Determination of inheritance pattern of different human characters (Widows Peak, ear loop, etc), risk estimation and genetic counseling.
14. Study of quantitative traits in humans: finger prints as model of polygenic traits
15. Study of Barr bodies in human cell nucleus
16. Dermatoglyphics in normal and mentally retarded subjects
17. Probability problems. Tossing of coins. X² test
18. Study of transformed bacteria on the basis of antibiotic resistance
19. PCR

Books Recommended:

1. Snustad, D.P., Simmons, M.J. 2003. Principles of Genetics. 3rd Ed., John Wiley and Sons Inc. New York, USA.
2. Tamarin, R.H. 2001. Principles of Genetics. 7th Ed., WCB publishers USA.



3. Lewin, B. 2013. GENE-VIII. Oxford University Press. UK.
4. Gardener, E.J., Simmons, M.J., Snustad, D.P. 1991. Principles of Genetics. John Wiley and Sons Ins. New York, USA.
5. Strickberger, M.W. 2015. Genetics. McMillan, New York. USA.(9780024181206)
6. PRINCIPALS OF GENETICS Gardner E.J., Simmons M.J. and Snistad A.P. (Latest available Addition)
7. Reference Books. Concepts of Genetics By Klug, W.S and Cummings M.R.
8. William S. Klug, 2014. Concept of Genetics, ISBN-11: 978-0321948915
9. Lewin's Gene XI BY Jocelyn E. Krebs et al. 2013, isbn-13:978-1449659851,ISBN-
10. Gene- XI by Lewin's,2013,ISBN:978-1449659851

IDS 352 Plant Physiology

Credit Hours 3(2+1)

Course Description

Plants are essential to humans and animals not only for food but also by maintaining our ecosystem. Understanding the plant physiology is an essential component for crop improvement and understanding of eco system. This course would enable students to understand how plants function and what are essential components to maintain/boost crop production.

Course Learning Outcomes

1. Be able to appreciate and understand how plants growth and maintain their metabolism.
2. Have a good understanding of key signaling pathways
3. The contribution of plants to provide health food How to improve plant growth

Course Contents

1. Photosynthesis: History of photosynthesis. Nature and units of light. Determination of oxygenic and anoxygenic photosynthesis. Ultrastructure of thylakoid vesicle. Various pigments and photosynthetic activity. Ultrastructure and composition of photosystem-I and II. Absorption and action spectra of different pigments. Mechanism of photosynthesis - light absorption, charge separation or oxidation of water (water oxidizing clock), electron and proton transport through thylakoid protein-pigment complexes. Photophosphorylation and its mechanism. CO₂ reduction (dark reactions) - C₃ pathway and Photorespiration, Regulation of C₃ pathway, C₄ pathway and its different forms, C₃-C₄ intermediates, CAM pathway. Methods of measurement of photosynthesis.

2. Respiration: Synthesis of hexose sugars from reserve carbohydrates. Mechanism of respiration- Glycolysis, Differences between cytosolic and chloroplastidic glycolysis, Oxidative decarboxylation, Krebs cycle, Regulation of glycolysis and Krebs cycle, Electron transport and oxidative phosphorylation. Aerobic and anaerobic respiration. Energetics of respiration. Pentose phosphate pathway. Glyoxylate cycle. Cyanide resistant respiration.

3. Translocation of Food: Pathway of translocation, source and sink interaction, materials translocated, mechanism of phloem transport, loading and unloading.



4. Leaves and Atmosphere: Gaseous exchange, mechanism of stomatal regulation. Factors affecting stomatal regulation.

5. Assimilation of Nitrogen, Sulphur and Phosphorus: The nitrogen cycle. Nitrogen fixation. Pathways of assimilation of nitrate and ammonium ions. Assimilation of sulphur and phosphorus.

Lab Outline:

1. To determine the volume of CO₂ evolved during respiration by plant material.
2. To determine the amount of O₂ used by respiring water plant by Winkler Method.
3. Separation of chloroplast pigments on column chromatogram and their quantification by spectrophotometer.
4. To extract and separate anthocyanins and other phenolic pigments from plant material and study their light absorption properties.
5. To categorize C₃ and C₄ plants through their anatomical and physiological characters.
6. To regulate stomatal opening by light of different colours and pH.

Recommended Books:

1. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
2. Dey, P.M. and Harborne, J.B. 1997. Plant Biochemistry. Harcourt Asia PTE Ltd. Singapore.
3. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.
4. Heldt, H-W. 2004. Plant Biochemistry. 3rd Edition, Academic Press, U.K.
5. Ihsan Illahi, 1991. Plant Growth, UGC Press, Islamabad.

IDS 353 Environmental Chemistry

Credit Hours 3(3+0)

Course Description

During this course students will study the chemistry of the air, water, and soil, and how anthropogenic activities affect this chemistry on planet Earth. This course is divided into 4 major parts that reflect the most pressing issues in Environmental Chemistry today: Radiation Ecology, The Atmospheric and Land Pollution, Green Chemistry, Organic Air Pollutants and Photochemical Smog, and Water Pollution.

Course Learning Outcomes

After Successful Completion of the course, the students will be able to;

EXPLAIN the basic concepts involved in Environmental Chemistry.

CLASSIFY the types of pollutants in air, water, soil, and biological matrices, and understand their fate in ecosystems.

FOLLOW standard analytical procedures to identify the types of pollutants harmful to human.

Maintain ethical conduct in lab and adhere to lab safety procedures while contributing effectively towards individual and/ or group goals.

Course Contents:

Atmospheric Pollution:

The atmosphere, composition, temperature and pressure profile, role of free radicals in the atmosphere, temperature inversion and photochemical smog, particulate matter in the



atmosphere, Industrial pollutants, atmospheric aerosols, acid-rain major sources, mechanism, control measures and effects on buildings and vegetation, global warming, major greenhouse gases, mechanism, control measures and global impact, the stratospheric ozone–the ozone hole, CFCs, ozone protection, biological consequences of ozone depletion.

Radiation ecology:

Global Environmental Changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, Radioactivity leakage, Environmental laws).

Water Pollution:

Water pollution and wastewater treatment, municipal, industrial and agricultural sources of pollution, heavy metals contamination of water, eutrophication, detergents and phosphates in water, water quality criteria, water purification: primary, secondary and advanced treatment, removal of nitrogen and phosphorous compounds from polluted water, organic matter in water and its decomposition.

Land pollution:

Soil and mineral resources, general principles of metal extraction, heavy metals contamination of soil, toxicity of heavy metals, bioaccumulation of heavy metals, organic matter in soil, macro and micro-nutrients in soil, ion-exchange in soil, soil pH and nutrients availability.

Green Chemistry:

Atom economy, integrated pest management control (IPMC), ionic liquids, super critical extraction technology, green synthesis, recycling, carbon dioxide sequestering, water-based paints.

Recommended Books:

- Baird, C. and Cann, M., Environmental Chemistry, 5th ed., W. H. Freeman & Company, (2012).
- Dara, S. S. and Mihsra, D. D., A Text Book of Environmental Chemistry and Pollution Control, 9th ed., S. Chand & Co. Ltd., (2004).
- **Singhi**, R. and Singh, V., Green Chemistry for Environmental Remediation, John-Wiley & Sons, Inc., (2011).
- Holloway, A. M. and Wayne, R. P., Atmospheric Chemistry, 1st ed., Royal Society of Chemistry, (2010).
- Vaclavikova, M., Vitale, K., Gallios, G. P. and Ivanicova, L. Water Treatment Technologies for Removal of High Toxicity Pollutants, Springerlink, UK, (2010).
- Manahan, S. E., Environmental Chemistry, 9th ed., CRC press, Taylor & Francis group, USA, (2009).
- Girard, J. E., Principles of Environmental Chemistry, 2nd ed., Jones and Bartlett publishers, (2010).
- Harrison, R. M., Monks, P., Farmer, J. G., Graham, M. C., Mora, S. J., Pulford, I. and Hulsal, C., Principles of Environmental Chemistry, 1st ed., Royal Society of Chemistry, (2007).
- Matalack, A., Introduction to Green Chemistry, 2nd ed., CRC press, Taylor & Francis group, USA, (2010).
- Wright, J., Environmental Chemistry, Routledge, (2003).



Sixth Semester

ZOO 361 Fisheries and Aquaculture

Credit Hours 3(2+1)

Course Description

This course provides students with a comprehensive understanding of the principles, practices, and challenges associated with the sustainable production of fish. Through a combination of lectures, laboratory demonstrations, field trips, and hands-on practical exercises, students will explore the biological, environmental, economic, and social aspects of aquaculture. Topics covered will include the history and development of aquaculture, species selection and breeding, hatchery management, grow-out systems, nutrition and feeding, disease prevention and treatment, water quality management, and regulatory frameworks.

Course Contents

History and significance of aquaculture; Study of management techniques and habitat improvement; Designing, construction, fertilization, manuring, stocking and harvesting of a fish pond; Study of native and exotic fishes of Pakistan; Shellfish and fin fish; Fishing gears and crafts/nets used in Pakistan; Fish ways; construction and importance. By products of fish industry; Methods of processing fish such as drying, salting smoking, curing, freezing etc; Study of fish parasites, common diseases and enemies of fishes. Pollution and its effect on fish population; Methods of population estimation by direct count, catch effort, mark re-capture method, tagging of fish; Artificial propagation induced spawning techniques; Marketing strategies; transport of fish and seed; Major problems of fishermen in Pakistan;

Practical

- Ø Collection and identification of common zooplanktons
- Ø Study of gut contents of fish
- Ø Statistical analysis of fish growth, length-weight relationship
- Ø Study of farm fishes of KPK
- Ø Visit to a fish farm/hatchery to study installations/methods of breeding Ø Prepared slides of fish parasites
- Ø Analysis of physical properties (temperature, light, colour, turbidity, conductivity etc.) and chemical properties (pH, oxygen, carbon dioxide, salinity, dissolved solids/salts) of water;
- Ø General methods of age growth studies; reading of age from scales, opercula, otolith and back calculation from bones;
- Ø Study of larvae, fry and fingerlings of a common fish, regulation of fishing, enactment of fishery legislation.

Books Recommended:

- Ø Ali S.S.1999 Freshwater Fishery Biology, Naseem Book Depo, Hyderabad, Pakistan.
- Ø Rath, R.H.1993 Freshwater Aquaculture, Scientific Publishers, Delhi,India.



- Ø Stickney, R. R., & Gatlin III, D. M. (2022). Aquaculture: An introductory text. Cabi.
- Ø Lucas, J. S., Southgate, P. C., & Tucker, C. S. (Eds.). (2019). Aquaculture: Farming aquatic animals and plants. John Wiley & Sons.
- Ø Rounsefell, G.A. and Everhart, W.H. 1953 Fisheries Science, John Wiley and Sons, New York
- Ø Mirza, M.R. and Bhatti, M.N. 1993 Pakistan ki Machlian aur Mahi Parwari Ferozsons, Lah

ZOO 362 Research Methodology and Bioethics

Credit Hours 3(2+1)

Course Description

Research Methodology and Bioethics is an essential course designed to equip students with the foundational skills and knowledge necessary for conducting scientific research in the field of zoology. Through a comprehensive exploration of various research methods and techniques, students will gain a deep understanding of the principles guiding biological inquiry and investigation.

Course Contents:

1. Introduction:

- a. Objectives of Research, Motivations

2. Research Process:

- a. Research methods vs. research methodology, scientific method
- b. Types of research, general steps involved in research
- c. Problems of research in Pakistan

3. Topic Selection:

- a. Problem identification for research, criteria and evaluation

4. Literature review:

- a. Importance and sources
- b. Referencing and citation and Bibliography
- c. plagiarism

5. Research Design:

- a. Parts, important features, important concepts in research design

6. Aims and objectives:

- a. Research objectives, qualities of research objectives

7. Material and methods:

- a. Bioethics, sampling, data collection and data analysis, sampling requirements, scales of measurement, error of measurement and its sources

8. Data Analysis:

- a. Processing, statistics in research, hypothesis testing, t-tests and ANOVA



9. Scientific Writing:

a. Difference between thesis/report/synopsis/research proposal.

b. Parts of synopsis/project proposal, parts of thesis/report

Budgeting: Cost estimates for a research project, funding sources e.g. USAID, HEC, DoST, HED, PMRC, WWF, PSF etc.

Text and Reference Books:

- Paul Leedy, 2004, Practical Research: Planning and Design (8th Edition), Jeanne Ellis Ormrod
- Creswell, J. W. (2013). Research Design Quantitative Qualitative and Mixed Methods Approaches. Sage.
- Hess-Biber, S. N. and P. Leavy. (2004). Approaches to Qualitative Research, A Reader on Theory and Practice. New York, Oxford University Press.
- Khan, J.A. (2008). Research Methodology. New Delhi: APH Publishing.
- Kothari, C.R., & Gaurav, G. (2014). Research Methodology: Methods and Techniques. New Delhi: New Age International.
- Kumar, R. (2011). Research Methodology: A Step By Step Guide for Beginners. Cornwall: SAGE Publications, Inc.
- Laurel, B. (2003). Design Research, Methods and Perspectives. London England, The MIT Press.
- Walliman, N. (2005). Your Research Project, 2nd Edition, A step by step guide for the first-time researcher. New Delhi, Vistaar Publications

ZOO 363 Ornithology

Credit Hours 3(2+1)

Course Description:

The course of ornithology explores the intricate world of bird starting from classification of birds to physiology and conservation. Students delve into avian anatomy, from feathers to flight muscles, and study physiological systems like respiration and digestion. They examine evolutionary adaptations, reproductive strategies, and communication behaviors. Practical sessions include bird identification, dissections, and data analysis. By course end, students grasp the form and function of birds, laying a foundation for further ornithological study and conservation efforts

Course Learning Outcomes:

On the successful completion of this course, students will be able to:

6. **ACQUIRE** the basic knowledge of the birds in the diversified habitats.
7. **UNDERSTAND** their behavior and possible their relationships to the natural habitats.
8. **SOLVE** the issues to detect minute morphological variations by using different high power spotting scopes in the field study for various habitats.
9. **ANALYZE** the likely impacts of changing climatic conditions on variety of birds in different ecosystems to sift in roosting, nesting and behavioural mechanisms.



Course Outline

- a. **Introduction to ornithology**; basic ecology and themes of study.
- b. **Classification** and taxonomy of birds up to orders and species
- c. **Evolution of birds**; evolution of bird flight, aerodynamics and aerial movements. Bird ancestry; development of feathers, types and their structure; plumage analysis.
- d. **Behavioral studies of birds**: song and sound dialects in birds; types of songs; preferred season and time for bird pleasure calls; distress calls. Courtship behavior in birds, bird foraging, nesting and roosting activities. Learned and imprinting mechanisms in birds; brood parasitism and importance.
- e. **Predator-Prey relationships**, mobbing impacts; foraging and territoriality scuffles; predator avoidance.
- f. **Physiology of birds**: types of food; mastication; digestion; metabolism, skeletal system; circulatory and nervous system. Role of kidneys in birds.

G. **Bird conservation strategies**; sanctuaries and importance of urban zoos in bird life.

Practical:

1. Identification characteristics and taxonomy of birds to orders and families.
2. Dissection of sparrow, pigeon or common myna.
3. Study of gut contents of birds to assess their feeding habits.
4. Bird watching and preparation of ethograms

Text and Reference Books:

1. Handbook of Bird Biology (2014). Cornell Lab. Ornithology. Princeton University Press. New Jersey, USA. Howell, S. N. G. (2010).
2. Lovette, I. J., & Fitzpatrick, J. W. (Eds.). (2016). Handbook of bird biology. John Wiley & Sons.
3. Richard Grimmett, Carol Inskipp and Tim Inskipp (2008). Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton Book Co.

ZOO 364 Parasitology

Credit Hours 3(2+1)

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

1. Assess general principles and concepts of animal parasitology
2. Analyze many of the disease conditions that animal parasites cause and to consider measures that may lead to control of these disease agents

Course Description. A parasitology course covers the general characteristics, biology and classification of parasites. It includes the study of host-parasite relationships. It also outlines the diagnostic tools and methods through laboratory techniques. A portion of the course also explain basics of pathology and immunology

Course Outline

History and scope of parasitology



Evolution of parasites.

Zoogeography of parasites. Niches, habitats and environments.

Parasite fauna in different phyla

Parasitism. Phoresis. Hyperparasitism. Parasitoides. Mechanism of parasitic invasion.

Present status of parasitic diseases in the World. Emerging and re-emerging parasitic diseases.

Diagnostic parasitology: Sampling techniques (blood, stool, urine, sputum, biopsy, skin scrapping, swabs, ectoparasites, soil), sample preservation, processing, observation and identification of various parasitic forms.

Evolutionary associations between parasites and hosts

Parasitism and sexual selection

Evolution of virulence

Pathology and Immunity

The cell and cell injury and its relationship to disease. Acute and chronic inflammations, wound healing, disorders of growth, benign and malignant tumors in case of infections. Immunity

Practicals

1. Examination of different living animal hosts (domestic and wild) for collection, preservation, mounting and identification of Ecto and endo parasites.

2. Microscopy /study of permanent slides of parasites

3. Study of Staining techniques for parasites

4. Study of Culture methods of parasites

Books Recommended.

Arora, D.R. and Arora B. (2005). Medical Parasitology. CBS Publishers and Distributors, New Delhi.

Belding, D. L. Meredith. (1956). Textbook of Parasitology. New York.

Roberts, L.S., & Janovy, J. Jr. (2009). Foundations of parasitology (8th ed.). Bostan: McGraw Hill, Publishing.

Sastry, A. S., & Bhat, S. (2019). Essentials of medical parasitology (2nd ed.). Dehli: Jaypee Brothers Medical Publishers.

IDS 361 Principles of Biochemistry

Credit Hours 3(2+1)

Course Overview: This course introduces the chemical foundations of biological macromolecules, emphasizing their structure, function, and relevance to life sciences. It is tailored for students in biological disciplines, especially zoology, and provides a molecular understanding of cellular processes.

Macromolecules – Structure and Function

1. Carbohydrates

- Introduction and biological significance
- Classification: monosaccharides, oligosaccharides, polysaccharides
- Stereoisomerism in carbohydrates
- Structural and functional roles of:
 - Monosaccharides (e.g., glucose, fructose)
 - Oligosaccharides (e.g., sucrose, lactose)



- Polysaccharides (e.g., starch, glycogen, cellulose)

- Glycosaminoglycans and glycoconjugates: structure and physiological roles

2. Amino Acids, Peptides, and Proteins

- Classification and properties of amino acids
- Acid-base behavior and isoelectric point
- Peptide bond formation and primary structure
- Conjugated proteins and their biological roles

3. Protein Organization and Function

- Structural levels: primary, secondary, tertiary, quaternary
- Covalent and non-covalent interactions in protein folding
- Functional proteins:
 - Hemoglobin and oxygen transport
 - Cytochrome and electron transport
 - Chymotrypsin and enzymatic activity
 - Alpha-keratin and collagen in structural support
- Proproteins: examples and activation mechanisms

Enzymes

- Definition and biological importance
- Classification and nomenclature (IUB system)
- Mechanism of enzyme action
- Enzyme inhibition
- Factors affecting enzyme activity

Lipids

- Introduction and classification
- Fatty acids: types and properties
- Storage lipids: triacylglycerols and waxes
- Structural/membrane lipids:
 - Glycerophospholipids (ether and ester linkages)
 - Galactolipids and sulfolipids
 - Sphingolipids: types and functions
 - Sterols: structure and biological roles

Nucleic Acids

- Types: DNA and RNA
- Structure and roles of nitrogenous bases
- Nucleosides and nucleotides
- DNA and RNA molecular architecture
- Double helical structure of DNA: organization and chemical features

Practical:

Estimation of glucose from blood serum or any other fluid using ortho Toluidine technique.

Tests for detection of carbohydrates in alkaline medium.



Tests for detection of carbohydrates in acidic medium.
Tests for detection of Disaccharides.
Tests to demonstrate relative instability of glycosidic linkage in carbohydrates.
Detection of Non-Reducing sugars in the presence of reducing sugars.
Demonstration of Acid Hydrolysis of Polysaccharide.
Determination of pKa values of an amino acid by preparation of titration curves
Preparation of standard curve of proteins by Biuret method.
Estimation of blood serum proteins or any unknown concentration of protein using Biuret technique.

Recommended Books

1. Lehninger principle of biochemistry by David L.Nelson and Michael M.Cox , 7th latest edition,ISBN-10:1-4641-2611-9,ISBN-13:978-14641-2611-6
2. Biochemistry by Jeremy M. Berg, John L. Tymoczko; LubertStryer ,ISBN-10:1429229365,ISBN-13:97814229229364
3. Berg, J. M.,Tymoczko,J. L., LubertStryer. 2010. Biochemistry. 7th Ed.
4. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D, Darnell, J. 2012. Molecular Cell Biology.
5. David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Ed., Macmillan Worth Publishers, New York.
6. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Voet. D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry, John Wiley and Sons, Inc., New York.
7. Zubay, G.,1995. Biochemistry, 4th Ed., Wm. C. Brown Publishers, Inc., Oxford, England.
8. Stryer, L., 1995. Biochemistry, 6th Ed., W.H. Freeman and Company, New York
9. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan Worth Publishers, New York.
10. McKee, T., McKee, J.R. 2003.Biochemistry:
11. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
12. Lodish, H., Berk, A., Zipursky, S. L., Paul.M., Baltimore D,Darnell, J. 2012. Molecular Cell Biology.
13. McKee, T., McKee, J.R. 2003.Biochemistry:
14. The Molecular Basis of Life. 3rd Edition, McGraw-Hill
15. Molecular cell biology W.H Freeman by Lodish, Berk, Krieger, Scott, Bretscher,Ploegh and Matsudaira 8th edition/latest edition,ISBN:1464183392,ISBN-13:97814641183393

Textbook for Practical:

- Plummer, David T., 1990. An Introduction to Practical Biochemistry, 4th Ed. McGrawHill Book Company, London.
- Wilson, K and Walker, J., 1994. Practical Biochemistry: Principles and Techniques, 4th Ed., Cambridge University Press.
- Sawhney, S.K and Singh, R., 2008. Introductory Practical Biochemistry, Narosa Publishing House, New Delhi, India



IDS 362 Biostatistics

Credit Hours: 3(2-1)

COURSE OBJECTIVES:

This course helps students to understand the basic concepts of statistics, its nature, scope, and importance with special focus as a field of knowledge and its use relevance to biological or chemical, or social sciences. This course will equip and prepare students to evaluate and interpret basic descriptive and inferential statistics, and the design of research and data analysis in any field of scientific investigation.

COURSE LEARNING OUTCOMES:

Upon successful completion of the course, the student will:

Gain a strong foundation in basic statistical and probabilistic concepts which extends to critical thinking, problem-solving, and data analysis skills. This course will equip students with essential skills and knowledge that can be applied across diverse academic and professional domains, enhancing student's problem-solving abilities, data analysis skills and analytical thinking.

Topics	Students Learning Outcomes
1. Introduction to Statistics and Statistical Thinking	1.1. Define statistics, the science of statistics and its importance, application of statistics in economics or management sciences. 1.2. Role of statistics in critical thinking and ethics 1.3. Fundamental elements of statistics 1.4. Basic terminologies in statistics 1.5. Branches of statistics (descriptive & inferential statistics). 1.6. Define data, types of data/variables, sources of data. 1.7. Measurement scales (nominal, ordinal, interval, ratio) 1.8. Exercises



2. Data Representation	2.1. Introduction to data representation 2.2. Basic principles of classification and tabulation 2.3. Construction of frequency distribution (discrete & continuous) 2.4. Diagrams, graphs, and their construction (Bar charts, Pie chart, Histogram, Frequency polygon & Frequency curve, Box and Whisker plot, Stem and Leaf plot) 2.5. Exercises
3. Numerical Descriptive Measures	3.1. Define measures of central tendency 3.2. Different types of averages (A.M, H.M, G.M etc.) 3.3. Other measures of central tendency (Median and Mode) 3.4. Relative merits and demerits of averages 3.5. Measures of skewness and kurtosis 3.6. Shape of distributions 3.7. Define measures of dispersion 3.8. Absolute & relative measure of dispersion 3.9. Different types of absolute dispersion (Range, Variance, Standard Deviation, Inter-quartile Range) 3.10. Relative dispersion (Coefficient of variation) 3.11. Exercises



4. Introduction to Sampling Theory	4.1. Define sample, sampling, sample design, and sample frame. 4.2. Sampling with and without replacement 4.3. Types of error in sampling 4.4. Random sampling (simple, stratified, cluster, systematic, & multistage sampling) 4.5. Non-random sampling (convenience, purposive, quota, & snow-ball sampling) 4.6. Exercises
5. Introduction to Probability	5.1. Define probability, probability definitions (classical/priori, relative/posteriori, axiomatic) 5.2. Basic terminologies (sample space, sample points, events, mutually & not mutually exclusive events, exhaustive events) 5.3. Define set theory, set operations and their application in probability. 5.4. Rules of probability (additive, multiplicative and law of complement) 5.5. Exercises
6. Introduction to Hypothesis Testing	6.1. Define hypothesis testing & estimation. 6.2. Types of hypotheses (null & alternative/research hypothesis) 6.3. Errors in decision making (Type I and Type II) 6.4. Test statistic 6.5. Critical value, rejection/acceptance region 6.6. General pr
7. Hypothesis Testing-Single Population	7.1. Z distribution, one sample Z test 7.2. Degree of freedom 7.3. T distribution, one sample T test 7.4. Chi-square distribution, Chi-square test of association 7.5. Exercises



8. Design of Experiments (For Botany students only)	8.1. Define concept and design of experiments. 8.2. Principles of experiment 8.3. Planning of experiment 8.4. Replication and Randomization
	8.5. Field plot technique 8.6. Layout and analysis of CRD
9. Hands-on Statistical Packages	9.1. Introduction to SPSS, defining variables, data punching/entry. 9.2. Hands-on SPSS (data analysis and visualization).

RECOMMENDED BOOKS:

1. Zar, J. H., (2013). **Biostatistical Analysis**. Dorling Kindersley Publication.
2. Mann, P. S., (2010). **Introductory Statistics**. Wiley Publisher.
3. Quinn, G., Keough, P., (2011). **Experimental Design and Data Analysis for Biologists**. Cambridge University Press.
4. Pagano, M., Gauvreau, K., (2000). **Principles of Biostatistics**.
5. Walpole, R. E. (1982). **Introduction to Statistics**, 3rd Ed., Macmillan Publishing Co., Inc. New York.
6. Field A. (2013). **Discovering Statistics with IBM SPSS Statistics**. 4th Edition. SAGE Publication Ltd.
7. Sher Muhammad Chaudhry (2009). **Introduction to Statistical Theory, Part I & II**.

Seventh Semester

7 th Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO471	Major Core: Wildlife Conservation & Management	3(2-1)
ZOO472	Major Core: Economic Zoology	3(2-1)
ZOO473	Major Elective: Applied Entomology	3(2-1)
ZOO 474	Major Elective Mammalogy	3(2-1)
ZOO 475	Internship	3
IDS-471	Interdisciplinary: Microbiology & Immunology	3(3-0)
Total Credit Hours		18

ZOO 471 Wildlife Conservation & Management

Credit Hours 3(2+1)

Course Description:



This course offers basic understanding of what is wildlife, it's importance, values and the need to conserve wildlife. The course encompasses basic understanding of wildlife management to the intergovernmental treaties and conventions. It offers understanding of different types of conservation, protected areas categories and management. Students will also gain deep understanding of the IUCN red list criteria and categories. The course is designed with special emphasis on examples from wildlife management practices carried out in Pakistan.

Course Learning Outcomes:

Upon successful completion of this course, the student will be able to:

1. ACQUIRE theoretical knowledge about the identification, distribution, status, conservation and management of amphibians, reptiles, birds and mammals of major importance in Pakistan
2. UNDERSTAND the protected area system (Game Reserves, Wildlife Sanctuaries and National Parks)
3. SOLVE the threats to wildlife by applying the scientific principles and modern technologies (Sustainable development through local community participation).
4. ANALYSE, interpret and synthesize data and other information about the population of wildlife

Wildlife an Introduction

Definition and Introduction

Scope and Importance of Wildlife

Distribution, Status of important wildlife species of Pakistan; Ungulates, Carnivores, Game birds, Reptiles and amphibians

Values of Wildlife

Causes of Biodiversity loss

Need for Wildlife Conservation

Wildlife Management and Conservation

History of Wildlife Management

Habitat Management

Adaptive Management

Experimental Management

In Suito- Conservation and Ex-Suito Conservation: Zoos, Parks, Aivaries; Role of zoos in wildlife conservation and education,

Standards and guidelines for zoo management (e.g., WAZA, AZA standards)

Protected Areas;

Protected Areas Categories and Criteria;

Protected Areas of Pakistan; Types, National Parks, Game Reserves, Wildlife Sanctuaries,

Ramsar Convention;

Ramsar Criteria b. Wetlands; threats to wetlands c. Ramsar Sites

Wildlife rules and regulations in Pakistan

Provincial Rules, b. Federal Management of Wildlife (NCCW)

National and International agencies involved in conservation and management of wildlife

National Organizations b. International Organizations

Overview of key international conventions (CITES, CBD, CMS), Pakistan's role and commitments under these conventions



IUCN Red List Criteria and Categories:

Concepts of Threatened Species, Threatened Categories; Critically Endangered, Endangered, Vulnerable, Near Threatened

Practicals:

Visit to protected areas of Pakistan (Captive, Semi-captive and Wild Areas)

Ecological Indices

Animal Distribution

Maps

Text and Reference Books:

Deal, K. H. (2016). Wildlife and natural resource management. Cengage Learning.

Ali. S.S. 2005 Wildlife of Pakistan.

Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.

Smith, R.L. 1980. Ecology and Field Biology, Harper and Row.

Roberts, T. J., 1991, 1992. The Birds of Pakistan, Vol. I and II. Oxford University Press

Roberts, T. J., 1997. The Mammals of Pakistan, Oxford University Press

Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.

Wildlife of the Punjab, Punjab Wildlife Department.

Khan M. S. 2011, Amphibian and Reptiles of Pakistan

Mirza Z.B. 2011 Biodiversity of Pakistan

ZOO 472 Economic Zoology

Credit Hours: 3 (2+1)

Course Description

Economic zoology is designed to prepare students to utilize their knowledge of zoological science for economic uplift of individuals and communities. The course studies animals of economic importance and their rearing, farming and utilization for business and/or sustenance purposes. The course may also include practical sessions such as field trips, laboratory work, and internships to provide hands-on experience to students. Additionally, students may be required to study the economic and social impact of animal production and management on human societies.

Course Learning Outcomes

Upon successful completion of the course, the student will be able to:

1. ACQUIRE basic knowledge of Commerce and Economics with relation to Zoology
2. UNDERSTAND the Economic relationship of Animals with Humans
3. SOLVE problems related to animal husbandry and pest management by applying theoretical knowledge with practical efficacy
4. ANALYZE and enhance Animal husbandry techniques by using different Entrepreneurship skills
5. EVALUATE problems using practical knowledge in Zoology
6. DEMONSTRATE the Economy based interactions of Man and Animals



Basic concepts in Economic Zoology.

Parasitic protozoans and human disease. Economic importance of protozoa.

Vectors of human and domestic animals. Ecto- and Endo-parasites of fish, poultry, cattle and Man (Crustacea, Helminthes and Arachnida).

Apiculture, and Sericulture, Lac insect culture and Pearl culture Aquaculture and Fisheries (Edible Fresh water, Pond and Marine fish, Prawns, Pearl oysters).

Bird farming (Poultry, Quail, Turkey, Ostrich and Pigeon).

Practical:

1. To study the prepared slides of various types of ecto- and endo-parasites.
2. To observe and study Museum specimens of vertebrate and invertebrate
1. pests of important crops and stored grains in Pakistan.
2. To visit Honey Bee farm. Write a report on their observations.
3. Visit to Sericulture farm in a nearby locality and write a report on their observations.
4. Study visit to fish Hatchery, Nursery ponds, Stocking ponds, Commercial fish breeding farms and report writing.
5. Identification of important species of Fish and their natural animal.
6. Visit to any bird farm and write a report on their observations.

Text and Reference books:

1. Economic Zoology. Ravindranathan, K. R. 2003. 1st ed. Dominent Publishers and Distributers. New Delhi. India
2. Principles of Wildlife Management. Bailey, J. A. 1986. John Wiley and Sons Inc.USA.
3. Wildlife Ecology and management. Robinson, W. L. and Bolen, E. G. 1984. McMillan Publishing Company. Cambridge, UK.
4. A Primer of Conservation of Biology. Primack R. B. 2000. 2nd ed. Sinauer Associates Inc. USA.
5. Animal biodiversity of Pakistan. Mirza, Z. B. 1998. 1st ed: Printopack, Rawalpindi. Pakistan.
6. Ahmad, R. and Muzaffar, N., 1987. Rearing of Silkworm. Misc. Pub. Pak. Agric. Res. Council, pp. 53.
7. Akhtar, M. and Muzaffar, N., 2008. Introduction to Apiculture, Department of Zoology, Punjab University Press, 36 pp.
8. Anon, 1986. The Hive and the Honeybee. Dadant& Sons. Illinois, USA, pp. 740.

ZOO 473 Applied Entomology

Credit Hours 3(2+1)

Course Learning Outcomes

Upon successful completion of this course, students will:

- Understand the basic anatomy, physiology, development, and ecology of insects
- Be able to identify common orders of insects and understand their natural history from a broad perspective
- Understand the concept of integrated pest management (IPM) and be able to place specific pest control tactics within an IPM framework



- Be able to identify major insect pests of Illinois and the surrounding region by sight, and be able to apply the process of insect identification to previously un-encountered specimens

Introduction to Applied Entomology

Principles of apiculture, sericulture and lac culture.

General characteristics, life cycles and habits of insects of medical importance

Mosquito

Sand fly

General characteristics, life cycles and habits of insects of veterinary importance

Horse fly

Blow fly

Insect pests of Agriculture

Rice

Sugarcane

Insect pests of Household

Cockroach

Silver fish

Insect pests of Store grains

Red flour beetle

Rice Weevil

Pest Management

- a. Cultural, legislative Control
- b. Physical and Mechanical Control
- c. Biological Control
- d. Chemical Control
- e. Other approaches; Genetic, integrated control
- f. Relative merits of various types of insect control.
- g. Pest's management practices in Pakistan- oriental review.

Practical:

Collection, identification and preservation of different pests and other insects of medical and veterinary importance. Study of sericulture and apiculture. Operation of various types of sprayers. Dusters, fumigation emulsions. Preparation of insecticide emulsions in different concentration. The record of laboratory and fieldwork will be maintained and presented at the time of examination.

Books Recommended:

- a. Atwal, A. S. (1984) Agricultural pests of India and Southeast Asia. Kalyani Publishers
Delhi
- b. Imms, A.D. (1957) A General Textbook of Entomology. 9th ed. Revised by O. W.
- c. Metcalf, G. L. & Flint, W.P. (1962) Destructive and useful insects. Mc Graw Hill New York.



- d. Ross, H. H., Herms, W. E. & Janes, M. T. (1982) A text book of Entomology. John Wiley and sons, New York
- e. Herms, W. E. & Janes, M. T. Medical Entomology. The Macmillan Co. New York
- f. Carter, W. Insects in relation to plant diseases.
- g. Green, M. B. Hartley, G.S. & West, T.P. Chemicals for crop protection and pest control, Pergamon Press, New York
- h. De Bach, P. Biological control of insect pests and weeds. Chapman and Hall, London.
- i. Matheson, R. (1950). Medical Entomology. Comstock Publishing Associates, N.Y.

ZOO 474 Mammalogy

Credit Hours 3(2+1)

Course Description

In this course students will learn about mammals, physiological adaptations of mammals, its behaviour, impact of mammals on ecosystem and their relation to natural habitats. This course offers evolutionary perspective and geographical distribution of mammals across the globe. The course will be offered with an special emphasis on mammalian fauna of Pakistan.

Course Learning Outcomes:

Upon successful completion of the course, the student will be able to:

1. **ACQUIRE** the basic knowledge of the mammals in diversified ecosystems.
2. **UNDERSTAND** the behavior of the mammals and their relationships to the natural habitats.
3. **SOLVE** the problems in the mammalian study using scientific approaches and methods.
4. **ANALYZE** the impacts of mammals on the ecosystem and likely impacts on economy.
5. **UNDERSTANDING** the role played by mammalogists in the conservation and management of mammals.

Course Outlines:

- a. **Introduction and History of mammalogy**; basic characteristics of mammals; diversified habitats for mammals in Pakistan and various continents.
- b. **Mammalian phylogeny**; dentition and dental formulae, cranial characteristics, evolution of mammals. Concepts of viviparity and ovo-viviparity.
- c. **Biogeography**; mammalian radiations, biogeography of mammals of Pakistan, occurrence, habits and varied habitats, importance to ecosystems and negative values.
- d. **Food and feeding strategies**; preferred food sources of mammals, foraging habits, diurnal and nocturnal feeding regimes of mammals; ecological constraints and mammalian adaptations. Concepts of stenophagy and euryphagy.



- e. **Population dynamics of mammals**; rates of natality, mortality, immigration and emigration
- f. **Population modeling concepts in mammals**; mammalian crowding and scuffles with respect to various environments.
- g. **Communication and social organization**; chemical signaling in mammals, types and causes of occurrence, communication skills and emergence of mammalian call notes.
- h. **Mammalian Adaptations**; concept of torpor formation, aestivation, hibernation, acoustic lateralis systems in mammals. Concept of molecular basis of mammalian adaptations.
- i. **Behavior of mammals**; home range, territoriality, predation pressure, evolutionary arms races and competition for resources.

Practical:

- 1. General survey of mammalian species (Visits to zoological museums and zoos and field study)
- 2. Study of techniques for the collection of mammals, their identification, and systematic relationships
- 3. Comparative study of the mammalian skeleton
- 4. Dissection of a rabbit or rat to expose its different systems

Text and Reference Books:

- 1. Vaghuwan, T. A., J. M. Ryan and N. J. Czaplewski. 2010. Mammalogy. 5th Ed. The John Hopkins University Press, New York, USA.
- 1. Feldhamer, G. A., L. C. Drickamer, S. H. Vessey, J. F. Merritt and C. Krajewski. 2007. Mammalogy: Adaptation, Diversity, Ecology. 3rd Ed. The John Hopkins University Press, New York, USA.
- 2. Genoways, H.H., 2000. Current Mammalogy. Plennium Press, New York

IDS 471 Microbiology and Immunology

Credit Hours 3(3+0)

Course Learning Outcomes

- 1. Understand the major structures of bacterial cells, their functions and assembly and diversity of microbes
- 2. Understand the main ways bacteria exchange DNA
- 3. Recognize roles microbes play in the environment as well as in disease
- 4. Identify the growth phases of bacteria and how growth can be measured
- 5. Understand how the host organism responds to virus infection and develops immunity to future infection by the same virus
- 6. Understand the mechanisms by which some viruses evade host immune defenses
- 7. Understand the challenges faced in the global delivery of vaccines to eradicate select viral pathogens.
- 8. Understand the mechanisms by which some viruses evade host immune defenses



Course Contents

The beginnings of Microbiology: Discovery of the microbial world; Discovery of the role of microorganisms in transformation of organic matter, in the causation of diseases, development of pure culture methods. The scope of microbiology.

Microbial evolution, systematics, and taxonomy; Characterization and identification of microorganisms.

Viruses: Bacteriophages and phages of other protests. Replication of bacteriophages. Viruses of animals and plants; History, structure, and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses.

Morphology and fine structure of bacteria: Size, shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall, cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material.

The Cultivation of Bacteria: Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation.

Reproduction and growth of bacteria: Modes of cell division, new cell formation, Normal growth cycle of bacteria, synchronous growth, continuous culture, quantitative measurement of bacterial growth; Direct microscopic count, Electronic enumeration of cell numbers, the plate count method, Membrane-filter count, Turbidimetric method, Determination of nitrogen content, Determination of the dry weight of cells, the selection of a procedure to measure growth, Importance of measurement of growth.

Eukaryotic Microorganisms: Algae: Biological and economic importance of algae; Characteristics of algae; Lichens. Fungi: Importance of fungi; Morphology; Physiology and reproduction, Cultivation of fungi.

Prokaryotic diversity Bacteria: Purple and green bacteria; cyanobacteria, prochlorophytes, chemolithotrophs, methanotrophs and methylotrophs, sulfate and sulfur-reducing bacteria, homoacetogenic bacteria, Budding and appendaged bacteria, spirilla, spirochetes, Gliding bacteria, Sheathed bacteria, Pseudomonads, Free living aerobic nitrogen fixing bacteria, Acetic acid bacteria, Zymomonas and Chromobacterium, Vibrio, Facultatively aerobic Gram-negative rods, Neisseria and other Gram-negative cocci, Rickettsias, Chlamydias, Gram-positive cocci, Lactic acid bacteria, Endospore forming Gram-positive rods and cocci, Mycoplasmas, High GC Gram-positive bacteria. Actinomycetes, Coryneform bacteria, propionic acid bacteria, Mycobacterium, Filamentous Actinomycetes.

Prokaryotic Diversity: Archaea: Extremely Halophilic archaea, Methane producing archaea: Methanogens, Hyperthermophilic archaea, Thermoplasma.

IMMUNOLOGY

Course Contents

Immunology: Immunobiology, Immunophysiology, Immunopathology.

Immunity: Natural and acquired immunity, Active and passive immunity.

Antigens and elicitation of immune responses: antigens and their types, antigenicity and



immunogenicity, factors important for immunogenicity of an antigen, cell mediated and humoral: nature of antigens, genetic constitution of individuals and route of administration.

Immunoglobulins: Synthesis of antibodies, Theories of antibodies synthesis.

Detection and application of antigen-antibody reactions: in vivo and in vitro reactions.

Monoclonal antibodies: Importance, synthesis, isolation and applications

Major histocompatibility complex: types and importance, diversity in MHC proteins.

Cellular basis of immune response: Origin of lymphocytes, Primary and secondary lymphoid organs,

Specific response of individual lymphocytes to antigenic stimulation, Histological features of immune response.

Hypersensitivity: Immediate hypersensitivity (anaphylaxis, antibody dependent cytotoxicity, Immune complex mediated disease, and stimulatory hypersensitivity), Delayed type or cell mediated hypersensitivity.

Immunological tolerance and autoimmunity: Tolerance, autoimmune diseases and types, factors responsible for autoimmunity.

Transplantation immunology, Tumor immunology, Immunity against infectious diseases, Immuno deficiency diseases, Immunity, and malnutrition.

Immunization; Immunization procedures, Vaccines, and their types.

Books Recommended

1. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. 2001. Microbiology:

A Human Perspective, McGraw Hill Higher Education.

2. Jacquelyn, G.G. 2001. Microbiology: Principles and Explorations, John Wiley & Sons Inc.

3. Madigan, M.T., Martinko, J.M. and Parker, J. 1997. Brock Biology of Microorganisms, PrenticeHall, London.

4. Benson, H.J. 1994. MICROBIAL APPLICATIONS: LABORATORY MANUAL IN GENERAL

MICROBIOLOGY, WMC Brown Publishers, England.

5. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. 1986. MICROBIOLOGY, McGraw Hill, London.

6. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. 1986. THE MICROBIAL WORLD, Prentice Hall, London.

7. Essential immunology. Roitt, I. 1990. 2nd ed. Black well Scientific Publications. Oxford, UK.

8. Stites, D. P., Stobo, J. D., Fudenberg, H. H. and Wells, J. V. 1990. Basic and clinical immunology.

Lange Medical Publications, USA.

9. Essentials of haematology. Hoff - Brand, A. B. and Pedit, J. E. 1981. Black well Scientific Publications. Oxford, UK

Eighth Semester

8 th Semester (Credit Hours)		
Course Code	Course Title	Credit Hours
ZOO481	Major Elective: Wildlife of Pakistan	3(2-1)
ZOO482	Major Elective: Parasitic Diseases in Animals and Human	3(2-1)



ZOO483	Major Elective: Endocrinology	3(2-1)
IDS 481	Computational Biology	3(3-0)
CP 489	Capstone Project	3(0-3)
Total Credit Hours		15

ZOO 481 Wildlife of Pakistan

Credit Hours 3(2+1)

Course Description:

The course wildlife of Pakistan presents wildlife biodiversity of Pakistan particularly focusing on terrestrial vertebrate animals; mammals, birds, reptiles and amphibians. It offers different eco-regions of Pakistan, game species of Pakistan, large carnivores and the associated conservation challenges. The course also highlights major existing and emerging threats to wildlife in Pakistan. Pakistan has established a large number of different categories of protected areas for conservation of wildlife however, each has its own unique benefits and challenges. The course also tours such cases with practical learning where conservation goals clash with livelihood goals.

Course Learning Outcomes

On the completion of the course, the students will:

1. Understand the major eco-regions and wildlife hotspots of Pakistan
2. Understand the diversity and distribution of wildlife in Pakistan.
3. Explore the roles and significance of protected areas in wildlife conservation in Pakistan.
4. Study the important species of mammals, birds, amphibians and reptiles
5. Examine international conventions and agreements related to wildlife conservation.
6. Study the rules and regulations governing zoos and captive wildlife.
7. Understand the various conservation challenges faced by wildlife of Pakistan

Course Outline

Zoogeographical Distribution of Wildlife:

Major biogeographic regions and ecozones of Pakistan,
Faunal regions of Pakistan: Himalayan, Baluchistan, Indus plains, and coastal zones.
Endemism and migratory species.
Factors affecting distribution of wild fauna of Pakistan (climate, topography, vegetation).

Mammalian Fauna of Pakistan:

Major mammalian fauna – Distribution, Status and Populations of carnivores, ungulates, rodents, bats, and primates.

Threatened mammals:

National Red List of Mammals; Markhor, Urials, Marco Polo sheep, Indus River Dolphin, Common Leopard, Asiatic Black bear, Himalayan Brown bear, Himalayan Lynx, Wolf, Snow Leopard, Freshwater otter, Pangolin etc.
Threats and conservation efforts for mammals. Markhor, Brown bear, Pangolin, etc

Avifauna of Pakistan:

Major Avifaunal Region of Pakistan; Indus Plain and Basin, The Highlands, The Arid Zone, Coastal belt.



Major avifaunal groups – waterfowl, raptors, passerines, game birds.

Migratory birds and flyways (Indus flyway).

Threatened birds: Houbara bustard, Western Tragopan, Pheasants etc.

Reptiles, Amphibians, and Fish

Major reptiles (Crocodiles, Turtles, Snakes, Lizards) and their conservation.

Amphibians and freshwater/marine amphibians.

Challenges and Opportunities of Wildlife Conservation in Pakistan

Climate change and its effects on wildlife.

Trophy Hunting; Case studies of Urial, Markhor, Ibex, etc; Socioeconomic, Ecological impacts

Human Dimensions of Wildlife

Illegal wildlife trade and trafficking.

Wildlife diseases and health monitoring.

Suggested Readings:

1. Roberts, T. J. (1997). The Mammals of Pakistan. Oxford University Press.
2. Roberts, T. J. (1991). The Birds of Pakistan (Vol. I & II). Oxford University Press.
3. Baig, K. J., & Rehman, H. (2006). Wildlife of Pakistan. Pakistan Science Foundation.
4. WWF-Pakistan. Biodiversity of Pakistan: Reports and Fact Sheets.
5. Ali, S. & Ripley, S. D. Handbook of the Birds of India and Pakistan.
6. Khan M. S. 2011, Amphibian and Reptiles of Pakistan
7. Mirza Z.B. 2011 Biodiversity of Pakistan
8. Latest Research Articles

ZOO 482 Parasitic Diseases in Animals and Human

Credit Hours 3(2+1)

Course Description: This course focuses on the Classification, morphology, biology, mode of transmission, pathogenicity, laboratory diagnosis and prophylaxis of protozoans and helminthic parasites infecting human beings and animals.

Course objectives:

Upon successful completion of the course, the student will be able to:

1. To identify main agents of parasitic diseases (protozoa, helminths, and arthropods) that affect domestic, wild, and human populations.
2. To describe life cycles and epidemiology
3. To recognize the significant role of wildlife and animal populations in the epidemiology of zoonotic infections.

Parasites of animals: Classification, morphology, biology, mode of transmission, pathogenicity, laboratory diagnosis and prophylaxis of protozoans and helminthic diseases
Trypanosoma, Eimeria, Babesia and Endolimax

Flukes – Dicrocoelium dendriticum, Paragonimus;

Cestodes–Diphyllobothrium latum, Dipylidium caninum

Nematodes – Oxyuris, Ostertagia, Dictyocaulus and Trichostrongylus.

Medical Parasitology

Classification, general morphology, biology, mode of transmission, pathogenicity, laboratory diagnosis and prophylaxis of



1. protozoan parasites: Naegleria fowleri, Giardia lamblia, Trypanosoma spp, Plasmodium spp, Cryptosporidium parvum
2. Trematodes: Fasciolopsis buski, Clonorchis sinensis, Paragonimus westermani.
3. Cestodes: Hymenolepis nana, Taeniasaginata. .
4. Nematodes: Trichuris trichura, Strongyloides stercoralis, Dracunculus medinensis, Brugia malayi.

Practicals:

1. Examination of different living animal hosts (domestic and wild) for collection, preservation, mounting and identification of protozoan and helminth parasites.
2. Study of permanent slides of protozoan parasites, microscopic examination of blood smears for protozoan parasites, isolation and identification of protozoan cysts and eggs of Helminth parasites from fecal samples.
3. Use of oculomicrometer and stagemicrometer for measurement of different stages of protozoans and helminthes (trophozoite, cysts, eggs, larva).
4. Studies of different sections (transverse, longitudinal, sagittal) of parasites by using microtomy method and histopathological studies of different types of infected tissues of the host.
5. Microscopic examination of blood smears for microfilaria.
6. Study on different zoonotic diseases.
7. Identification of helminth parasites of man.

Recommended Readings

1. Roberts, L.S., & Janovy, J. Jr. (2009). Foundations of parasitology (8th ed.). Bostan: McGraw Hill, Publishing.
2. Sastry, A. S., & Bhat, S. (2019). Essentials of medical parasitology (2nd ed.). Dehli: Jaypee Brothers Medical Publishers.

ZOO 483 Endocrinology

Credit Hours 3(2+1)

Course objectives:

1. To Understand fundamental principles of endocrinology
2. To understand the roles of endocrine system in maintaining homeostasis
3. To expound the clinical relevance of endocrinology in human diseases
4. Molecular mechanisms of hormone action and regulation

Course Outline:

A. An introduction to endocrinology and hormone regulation

- a) Overview of endocrine system
- b) Hormone classification and biosynthesis
- c) Hormone receptors and signalling pathways
- d) Regulation of hormone secretion and feedback mechanisms

B. Endocrine Hypothalamus and Pituitary Gland

- a) Hypothalamic pituitary axis
- b) Hypothalamic-hypophyseal portal system
- c) Hypothalamic hormones; regulators of endocrine system, origin and chemistry
- d) Anterior pituitary hormones: Hypothalamic pituitary regulation



- e) Posterior pituitary : release regulation and actions of vasopressin and oxytocin
- f) Causes and effects of over and under production of hypothalamic and pituitary hormones (acromegaly, gigantism and dwarfism, diabetes insipidus)

C. Thyroid Gland

- a) Hypothalamic- pituitary- thyroid axis
- b) Anatomy and histology of gland, formation and secretion of thyroid hormones, thyroid hormones in peripheral tissues, function of thyroid hormones
- c) Mechanism of action and regulatory factors of thyroid gland
- d) Causes and effects of hyperthyroidism and hypothyroidism (Graves' disease, goiter, myxedema, cretinism)

D. Parathyroid Glands

- a) Parathormone and its role in calcium metabolism
- b) Regulation of parathyroid hormone secretion
- c) Calcium and bone metabolism, calcium in the circulation
- d) Clinical significance of hypoparathyroidism and hyperparathyroidism

E. The Adrenal Glands

- a) Hypothalamic- pituitary- adrenocortical axis
- b) Adrenal medulla and catecholamines, anatomy , biosynthesis and mechanism of action
- c) Disorders of adrenal medulla, pheochromocytomas and paraganglioma
- d) Anatomy and physiology of adrenal cortex, glucocorticoids, mineralocorticoids and adrenal androgens, regulation and secretion
- e) Adrenocortical insufficiency (Addison crisis) and adrenal hyperplasia (Cushing Syndrome).

F. Reproductive Endocrinology

- a) Hypothalamic- pituitary- gonadal axis
- b) The ovaries and testes- anatomy and physiology, testosterone, estrogen, progesterone and inhibin; synthesis transport, functions and mechanism of action
- c) Ovarian disorders; polycystic ovarian syndrome, Turner syndrome (syndrome of gonadal dysgenesis) , testicular disorders; gynecomastia, cryptorchidism, seminiferous dysgenesis

G. Pancreatic and Gastrointestinal Endocrinology

- a) Pancreas- anatomy and physiology, hormones of the endocrine pancreas
- b) Pancreatic regulation and mechanism of action of insulin and glucagon
- c) Causes and effects of endocrine pancreatic disorders (Diabetes mellitus)
- d) Gastrointestinal hormones; gastrin, cholecystokinin, secretin and ghrelin

H. Endocrinology of Pregnancy and Lactation

- a) Placenta and corpus luteum; anatomy and physiology, hormones in maintaining pregnancy
- b) Hormones in lactation

Practicals :

1. Demonstration of endocrine glands and associated structures in dissections, transparencies, computer projections .



2. Histological and ultrastructure features of endocrine glands
3. Experiments to demonstrate regulation of hormones release
4. Studies of disorders of pituitary by observing anatomical and histological features
5. Studies of thyroid status in deficient and excess hormone functions
6. Studies of diabetes type 1 and 2 : epidemiology in population, studies of management of the type 2
7. Model studies of ovarian and testicular disorders
8. Studies of hormonal status in puberty and aging

Recommended Books:

1. Greenspan, F.S. and Strewler, G.J., 2011. Basic and clinical endocrinology, 9th Edition. PrenticeHall International Inc., London.
2. Bentley, P.J., 1998. Comparative Vertebrate Endocrinology 3rd Ed. Cambridge University Press, Cambridge.
3. Sam A., Meeran K. Endocrinology and Diabetes. Lecture notes. Wiley- Blackwell (2009) (basicscience and clinicalcontext).
4. LaycockJ, Meeran K. Integrative Endocrinology. Wiley-Blackwell (2013).
5. Rang H, Dale M and Ritter, J: Pharmacology, 4th ed., (1999). (relevant for drug information) 2nd Edition. The Oxford Textbook of Endocrinology and Diabetes DOI: 10.1093/med/ 9780199235292.003.0134
6. Yen & Jaffe's Reproductive Endocrinology: Physiology, Pathophysiology, and Clinical Management. Saunders – all editions are excellent (even the older editions)
7. Johnson MH. Essential Reproduction. 7th Ed. Wiley-Blackwell (2013) (relevant for some general background info on reproduction pitched for undergraduate students).
8. ChandraS.Negi, introduction to endocrinology
9. Charles Brook, Nicholas Marshall, essential endocrinology
10. Noris, vertebrate endocrinology
11. Iona R. Ilie, Introduction to Endocrinology
12. Richard I .G. Holt Neil A. Hanley, Essential endocrinology and diabetes 6th edition. With wiley desktop edition and coursesmart
13. Anand Kumar. Mona Sharma, Basics of Human andrology

Additional Readings:

1. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R., 1998. William's textbook of endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
2. DeGroot, L.J., Jameson, J.L. et al., 2012 Endocrinology, Vol. I, II & III, 10th Edition. W.B. Saunders, Philadelphia.
3. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
4. Neal, J.M., 2000. Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.

IDS 481 Computational Biology

Credit Hours 3(3+0)

Course Description

This course provides a foundational introduction to the field of computational biology, bridging the gap between biological questions and computational solutions. Students



will learn to harness the power of computational tools to organize, analyze and interpret complex biological data. Through a hands-on approach, students will gain practical experience with key softwares preparing them to tackle modern challenges in biological research.

Course outlines

Introduction, scope, applications, and importance of computational biology. Biological Databases and Data Retrieval (GenBank, PDB, UniProt). Sequence Alignment Techniques (global, local) using tools like BLAST and Clustal Omega and their interpretation. Phylogenetic and Evolutionary Analysis (tools like MEGA or PhyML). Genomics (NGS) & Transcriptomic data Analysis with Linux Basis & R Programming, Protein Structure Prediction and Analysis.

Molecular Docking and Drug Design. Machine Learning Applications in Computational Biology. Basics concept of Python programing and its global application

Practicals

1. Retrieving data from databases and understanding data formats
2. Sequence alignment using tools like BLAST and Clustal Omega
3. Create and interpret phylogenetic trees using tools like MEGA or PhyML
4. Use tools like AlphaFold or SWISS-MODEL for 3D structure prediction.
5. R programing basics
6. Interpret structures using visualization software like PyMOL
7. Perform molecular docking using AutoDock or similar software
8. Machine learning models for biological data analysis
9. Training on biological data with python scripts

Books and references

2. An Introduction to Computational Systems Biology, By Karthik Raman.
- 2) An Introduction to Systems Biology, By Uri Alon

Specialization Courses

The following four (4) specialization streams have been approved by the board of studies of the Department of Zoology and Academic council of the University of Chitral. The department concerned and / or affiliated college may consider offering the degree program with specialization or otherwise, keeping in view the available academic, human and infrastructural resources and adequate number of students opting the specialization determined by the department / affiliated college.

Specialization In Mammalogy

Specialization Elective Subjects For Bachelor of Science in Zoology (Mammalogy)			
Course Code	Course Title	Semester	Credit Hours
MAM-364	Major Elective: Evolution of Mammals	6th	3(2-1)
MAM-365	Major Elective: Ecology of Mammals	6th	3(2-1)



MAM-473	Major Elective: Mammalian Taxonomy & Systematics	7th	3(2-1)
MAM-474	Major Elective: Primatology	7th	3(2-1)
MAM -481	Major Elective: Marine Mammalogy	8th	3(2-1)
MAM -482	Major Elective: Zoonotic Diseases in Mammals	8th	3(2-1)
MAM -483	Major Elective: Mammalian Physiology	8th	3(2-1)
Total Credit Hours			15

Specialization in Wildlife Biology

Specialization Elective Subjects for Bachelor of Science in Zoology (Wildlife Biology)			
Course Code	Course Title	Semester	Credit Hours
WLB-364	Conservation Biology	6th	3(2-1)
WLB -365	Wildlife Study Techniques	6th	3(2-1)
WLB -473	Protected Area Management Planning	7th	3(2-1)
WLB -474	Captive Breeding of Wildlife	7th	3(2-1)
WLB -481	Sustainable Wildlife Tourism	8th	3(2-1)
WLB -482	Endangered Species Management	8th	3(2-1)
WLB -483	Wildlife Law and Policy	8th	3(3-0)
Total Credit Hours			15

Specialization Fisheries and Aquaculture

Specialization in Fisheries and Aquaculture			
Course Code	Name of Subject	Semester	Cr. Hours
FSAQ-364	Applied Fisheries	6 th	3



FSAQ -365	Ichthyology	6 th	3
FSAQ -473	Fisheries Economic & Business Management	7 th	3
FSAQ -474	Aquaculture Policy & Governance	7 th	3
FSAQ-481	Fish Farm and Hatchery Management	8 th	3
FSAQ -482	Climate Change & Fisheries	8 th	3
FSAQ -483	Cold Water Fisheries (Trout Fisheries)	8 th	3

Specialization In Parasitology

Course Code	Course Name	Semester	Credit Hours
PARA-364	Fundamentals of Parasitology	6 th	3 (2+1)
PARA -365	Immunology	6 th	3 (2+1)
PARA -473	Protozoology	7 th	3 (2+1)
PARA -474	Helminthology	7 th	3 (2+1)
PARA -481	Parasite Systematics, Ecology and Epidemiology	8 th	3 (2+1)
PARA -482	Parasite Ecology and Epidemiology	8 th	3 (2+1)
PARA -483	Wildlife Parasitology	8 th	3 (2+1)