



# University of Lakki Marwat

## Department of Zoology

### Semester 4<sup>th</sup>

S.No	Course Category	Course Title	Credits
1	Major	Animal Diversity-II (Chordates)	4 (3+1)
2	Major	Animals Form and Function II	4 (3+1)
3	Major	General Biochemistry	4 (3+1)
4	Major	Economic Zoology	3 (2+1)
5	Major	Animals Behaviour	3 (3+0)
		<b>Total Credits</b>	<b>18</b>

## **Animal Diversity-II (Chordates) 4 (3+1)**

### **Course Objectives**

The objectives of the course are:-

- To enable them to understand the Taxonomic characteristics of protochordates and chordates.
- To impart knowledge about the phylogenetic relationships of protochordates and various classes of chordates.
- To develop critical thinking about phylogeny of chordates with respect to their physiological adaptations, behavior and ecology.

### **Course Learning Outcomes:**

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

1. **ACQUIRE** the basic knowledge of Taxonomic characteristics of chordates.
2. **UNDERSTAND** the phylogenetic relations and diversity of Pisces, amphibians, reptiles and mammals.
3. **ANALYZE** the process of micro evolution within chordates.
4. **DEMONSTRATE** individually phylogenetic relationships of chordates and their diversity.

### **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.
- d. Phylogenetic relationships.

#### **2. Fishes:**

- a. Vertebrate Success in Water.
- b. Phylogenetic relationships of Pisces.
- c. Classification of Chondrichthyes, Osteichthyes, Dipnoi and Holocephalli
- d. Locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development of Chondrichthyes (*Scoliodon*) and Osteichthyes (*Cyprinus carpio* and *Wallago attu*).

#### **3. Amphibians:**

- a. The first terrestrial vertebrates. Characteristics of amphibians
- b. Phylogenetic relationships.
- c. Classification of amphibians and characteristics of order Caudata, Gymnophiona, and Anura.

- d. Structure and locomotory adaptations, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and
- e. Osmoregulation, 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 Crocodylia.
- c. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development of helonia, squamata, Rhynchocephalia and crocodylian.
- d. Further phylogenetic considerations.

#### **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 and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development.
- e. Migration and navigation.

#### **6. Mammals:**

- a. Classification, Specialized teeth, endothermy, hair and viviparity.
- b. Diversity of mammals.
- c. Adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behaviour, reproduction and development.

#### **Practicals:**

1. Classification and study of lab specimens of hemichordates, fishes, amphibians, reptiles, birds and mammals.
2. Visit to PMNH for the study of diversity of chordates.

#### **Books Recommended:**

1. Campbell, N.A. Biology. 9th Ed. 2011. Menlo Park, California Benjamin/Cummings Publishing Company, Inc.
2. Miller, S.A. and Harley, J.B. 2010. Zoology, 8th Edition (International) Singapore: McGraw Hill.
3. Miller, S.A. 2002. General Zoology Laboratory Manual. 5th Ed. (International), Singapore: McGraw Hill.
4. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 14th Edition (International), 2009. Singapore: McGraw-Hill.

# **Animal Form and Function-II 4 (3+1)**

## **(A Comparative Perspective)**

### **Course Objectives:**

#### **The Objectives of the courses are:**

- To teach about animals' diversity adapted in different strategies' for performance of their similar functions through modifications in body parts in past and present times.
- To impart understanding of diverse strategic structural adaptations in each of the functional systems of nutrition, excretion, osmoregulation and reproduction and development for effective survival in their specific conditions.
- To understand the organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
- To embrace the phenomena in basic structure of each system that determines its particular function.

### **Course Learning Outcomes:**

1. **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.
2. **Understand** that diverse forms adapted to perform the same functions are because of the different past and present conditions.
3. **Solve** of emergence of diversity of forms for the performance of similar function.
4. **Analyze** the requirements of diverse forms for the performance of similar function in their past and present needs.
5. **Evaluate** the adaptations in forms for its efficiency in managing the function in differing situations in the past and present times.
6. **Demonstrate** that a form is successfully adapted to perform a function adequately and successfully.

### **Course Outline:**

#### **1. Nutrition and Digestion:**

- a. Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion
- b. Animal strategies for getting and using food, diversity in digestive structures of invertebrates.
- c. The mammalian digestive system: gastrointestinal motility and its control
- d. 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 gallbladder in digestion.

#### **2. Temperature and Body Fluid Regulation:**

- a. 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

b. Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate.

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

### **3. Reproduction:**

a. Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction;

b. Sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes;

c. The human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function;

d. The human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation.

### **Practicals:**

1. Study of excretory system in an invertebrate and a vertebrate representative (Model).

2. Study of dissection system in invertebrate and a vertebrate representative (Dissection).

3. 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**

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

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

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

4. Campbell, N.A. 2002. Biology, 6th Ed. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

5. Kent, G.C., Miller, S. 2001. Comparative Anatomy of Vertebrates. New York: McGraw-Hill.

# General Biochemistry 4 (3+1)

## Course Objectives

The course aims to

- Provide in-depth knowledge about the polymerized organic compounds of life.
- Develop an understanding about the dynamism life as it proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work.
- Understand that inter-conversion is performed by various tools called as enzymes.
- Enable students to know how organisms harvest of energy for growth, duplication etc.

## Course Contents

**Amino acids, peptides and proteins:** standard amino acids, their structure and classification; acid/base properties of amino acids and their titration curves; peptides, their ionic behavior and amino acid composition, cytochrome c; **Proteins:** level of structural organization, example of structural and functional proteins.

**Enzymes:** Introduction; important characteristics of enzymes; immobilized enzymes; how enzymes work; example of enzymatic reaction; enzyme kinetics, enzyme rate of reaction and substrate concentration, how pH and temperature effect on enzyme activity.

**Carbohydrates:** Classification, types, important characteristics and structure of carbohydrates; cyclic structure of monosaccharides; cyanohydrins formation; disaccharides their types structure and function; polysaccharides, storage and structural types; structure and major functions of polysaccharides.

**Lipids:** fatty acids, their types and major characteristics; storage lipids, acylglycerols; waxes; structural lipids in membranes; major functions of lipids; lipoproteins, their types and major functions.

**Vitamins and cofactors:** occurrence, structure and biochemical function of vitamins B complex group.

**Metabolism:** detailed description of glycolysis and catabolism of other hexoses; regulation and bioenergetics of glycolysis. Anabolic role of glycolysis; fate of pyruvate under aerobic and anaerobic conditions, lactate, acetyl CoA and ethanol formation; alcoholic fermentation; gluconeogenesis, its regulation and significance in the tissues; feeder pathways in glycolysis; utilization of other carbohydrates in glycolysis phosphorolysis and starch; regulation of glycogen metabolism.

**Citric acid (TCA) cycle:** conversion of pyruvate to acetyl CoA, pyruvate dehydrogenase, a multi-enzyme complex; detailed description of citric acid cycle; bioenergetics and conservation of energy produced in the cycle. Anabolic or biosynthetic role of citric acid cycle intermediates; replenishing or anaplerotic reactions and their role; regulation of citric acid cycle; Electron transport and its components, oxidative phosphorylation, chemiosmotic theory, ATP synthesis, uncouple electron transport and heat generation.

**Lipid metabolism:** oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis of triacylglycerol; utilization of triacylglycerol; activation of fatty acids and their transportation to mitochondria; beta oxidation; bioenergetics of beta-oxidation; oxidation of unsaturated and odd chain fatty acids; omega oxidation pathway; biosynthesis of saturated fatty acid, supply of raw material for palmitic acid synthesis; fatty acid synthetase (FAS) multi enzyme complex; Ketone bodies their biosynthesis, utilization and role in the tissues; cholesterol metabolism: Steroid hormones.

**Nitrogen metabolism:** metabolic fate of amino acids; catabolism of amino acids; deamination and transamination; nitrogen excretion and urea cycle; regulation of urea cycle.

### **Practicals**

1. Preparation of standard curve for glucose by *ortho*-Toluidine method.
2. Tests for detection of carbohydrates in alkaline and acidic medium.
3. Tests for detection of Disaccharides.
4. Detection of Non-Reducing sugars in the presence of reducing sugars.
5. Demonstration of Acid Hydrolysis of Polysaccharide.
6. Separation and identification of various types of sugars, fatty acid and amino acid Thin Layer Chromatography (TLC).
7. Determination of pKa values of an amino acid by preparation of titration curves.
8. Biochemical tests for detection of different amino acids.
9. Separation of various protein fractions by precipitation method.
10. Demonstration of differential solubility of lipids in various solvents.
11. Quantitative analysis of phospholipids by estimation of inorganic phosphorous.
12. Quantitative analysis of Amylase activity from blood serum or liver.
13. Study on the effect of temperature on the enzymatic rate of reaction

### **Books Recommended**

1. Nelson, D. L., Cox, M. M. 2012. Lehninger Principles of Biochemistry. McMillan worth Publishers, New York.
2. Berg, J. M., Tymoczko, J. L., Lubert Stryer. 2010. Biochemistry. 7<sup>TH</sup> Ed.
3. Lodish, H., Berk, A., Zipursky, S. L., Paul. M., Baltimore D., Darnell, J. 2012. Molecular Cell Biology.
4. McKee, T., McKee, J.R. 2003. Biochemistry: The Molecular Basis of Life. 3rd Edition, McGraw Hill.
5. Wilson, K., Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th Ed., Cambridge University Press.

## **Economic Zoology 3 (2+1)**

### **Course Objectives:**

The objectives of the course are:-

- To educate scholars about the relationship of commerce with domestic animals, their products, by-products and associated farming practices.
- To teach the importance of human and domestic animal diseases and their vital relation to the economy.
- To provide knowledge about internal and external parasites and their effects on domestic animals and their farming practices.
- To familiarize with the value of studying various general practices, principles and techniques in farming and rearing of animals in sericulture (silk worms), apiculture (honey bees), aquaculture (fisheries, pearl culture, prawns and oysters), poultry (domestic fowl and ostriches) and cattle husbandry.
- To study the economics and principles of stored grained pests, pesticides and integrated pest management

### **Course Learning Outcomes:**

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

1. **ACQUIRE** basic knowledge of Commerce and Economics in 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

### **Course Outline:**

- 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).
  - Pests of pulse crops. Pests of oil seed crops. Stored grain pests. Pests of cotton. Pests of vegetables. Pests of fruits. Pests of tea.
- Apiculture, and Sericulture, Lac insect culture and Pearl culture

- Aquaculture and Fisheries (Edible Fresh water, Pond and Marine fish, Prawns, Pearl oysters). Economic importance of fishes.
- Bird farming (Poultry, Quail, Turkey, Ostrich and Pigeon).

**Practicals:**

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 pests of important crops and stored grains in Pakistan.
3. To visit Honey Bee farm. Write a report on their observations.
4. Visit to Sericulture farm in a nearby locality and write report on their observations.
5. Study visit to fish Hatchery, Nursery ponds, Stocking ponds, Commercial fish breeding farms and report writing.
6. Identification of important species of Fish and their natural animal.
7. Visit to any bird farm and write a report on their observations.

**Books Recommended:**

1. *Economic Zoology*. Ravindranathan, K. R. 2003. 1st ed. Dominant Publishers and Distributors. 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.
9. Anon, 1999. FAO Bulletins on Sericulture Nos. 1 & 2. FAO Office, Rome, Italy.

# Animals Behavior 3 (3+0)

## Course Objectives:

### The objectives of the course are:

- To impart knowledge about animal responses to external stimuli.
- To emphasize on different behavioural mechanisms (classical and recent concepts).
- To explain development of behavior with suitable examples of animals
- To understand role of genetic and neuro-physiology in behavioural development.

### Course Learning Outcomes:

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

1. **OUTLINE** the baseline information and knowledge for animal behavior.
2. **ASSOCIATE** the likely role of external and internal stimuli on various animals during the day, season and year.
3. **RELATE** daily behavioural rhythms in diurnal and nocturnal periodicities.
4. **PREDICT** and anticipate variety of animal actions (costs and benefits) as assessed by innate and learned behaviours; displays.
5. **INTEGRATE** the animal behavior as balanced mechanism to develop animal personality.

## Course Outline

### 1. Introduction

- Behaviour and its types.
  - Proximate and ultimate causes of behavior.
  - Development of behavior and impact of neural and physiological mechanisms; role of external and internal stimuli and animal responses. Physiology of behavior in changed environments.
  - Hormones and behavior in animals.
  - Innate behavior and innate releasing mechanisms; built in programmed performance by offspring to that of parents. Innate behavior of three spined stickle back fish.
  - Learned behavior and its mechanisms; quick learners' vs slow learners. Concept of animal cognition; key to understand and develop multiple behavioural choices. Ecological and genetics to maintain animal behavior. Concept of territoriality and defense in animals.
  - Circadian rhythms and concept of bio-rhythmicity in animals. Maintenance of internal biological clock to perform various diurnal and nocturnal periodicities.
- Costs and benefit ratios in behavior; successful foragers and winners of predator-prey relationships. Altruism and parental sacrifice to nurture the young.
- Competition for resources; survival of the most suitable individuals; evolutionary arms races in behavior.

- Social organization in animals and concept of group living; benefits and losses. Aggression, appeasement and selfish individuals. Social organization in insects and mammals.
- Communication in animals: Visual, Bioacoustic, electrical, chemical and tactile.
- Various types of chemical signals in animals' behavior and their importance in ecosystems.

**Books Recommended:**

1. Dngatkin, L. A. 2012. Principles of Animal Behavior. W.W. Norton and Co. New York.
2. Alcock, J. 2010. Animal behavior, an evolutionary approach. 9th Edition. Sinauer Publishers.
3. Scott, G. 2009. Essential Animal Behavior. Wiley publishers.
4. Scott, G. 2005. Essential Animal Behavior. Blackwell Pub. New York.
5. Goodenough, J., McGuire, B., Wallace, R.A. 2001. Perspective on Animal Behavior. John Wiley & Sons, New York.