Scheme of Study for

Master of Science (MSc) Zoology

(Morning/Evening) Program

Department of Zoology

Program:	**MSc Zoology**
Duration:	**02 Years**
Total Semester:	**04**

Head of Department
Department of Zoology
University of Lakki Marwat

Head of the Department

Director Academics
University of Lakki Marwat

Director Academics

University of Lakki Marwat (ULM) Khyber Khyber Pakhtunkhwa 28420, Pakistan

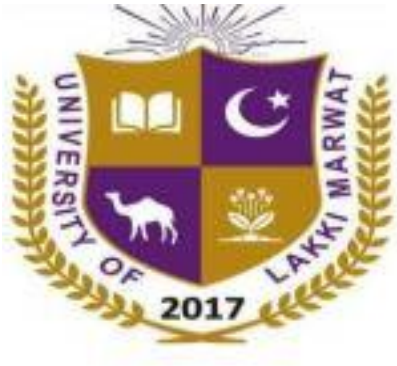
Semester	Course code	Course title	Credit
First	ZOO-311	Animal behavior	3 (3+0)
	ZOO-312	Biochemistry	4 (3+1)
	ZOO-310	Biostatistics	3 (2+1)
	ZOO-313	Cell and Molecular Biology	4 (3+1)
	ZOO-314	Zoogeography and Planetology	3 (2+1)
	Total Credit hours		**17 (15+2)**

Semester	Course code	Course title	Credit
Second	ZOO-321	Biological Techniques	3 (1+2)
	ZOO-322	Developmental Biology	4 (3+1)
	ZOO-323	Evolution and Principle of Systematics	3 (2+1)
	ZOO-324	Genetics	4 (3+1)
	ZOO-325	Research Methodology	2 (2+0)
	Total Credit hours		**16 (11+5)**

Semester	Course code	Course title	Credit
Third	ZOO-431	Animal Physiology	4 (3+1)
	ZOO-432	Entomology	3 (2+1)
	ZOO-433	Environmental Biology	4 (3+1)
	ZOO-434	Parasitology-I	4 (3+1)
	ZOO-435	Wild Life	2 (2+0)
	Total Credit hours		**17 (13+4)**

Semester	Course code	Course title	Credit
Fourth	ZOO-441	Applied Ent and Pest Management	3 (2+1)
	ZOO-442	Applied Fisheries	4 (3+1)
	ZOO-443	Bioinformatics	3 (1+2)
	ZOO-444	Immunology	4 (3+1)
	ZOO-445	Parasitology-II	4 (3+1)
	Total Credit hours		**18 (12+6)**

University of Lakki Marwat Khyber Pakhtunkhwa 28420, Pakistan



Course outline
Department of Zoology Program
MSc 1st Semester

S. No	Course code	Course Title	Cr. Hrs.
1	ZOO-310	Biostatistics	3 (2+1)
2	ZOO-312	General Biochemistry	4 (3+1)
3	ZOO-313	Cell and Molecular Biology	4 (3+1)
4	ZOO-314	Zoogeography and Paleontology	3 (2+1)
5	ZOO-311	Animal Behavior	3 (3+0)
Total credits			**17 (14+3)**

ZOO-310	Biostatistics 3	3 (2+1)

Aims and Objectives:

The course will provide knowledge about the importance and use of statistics in life sciences. It will help the students to understand the methods to analyze data pertaining to their research work and to assess the significance of their experimental designs. After this course students will be able to apply basic statistical procedures for analysis of data for practical and research.

Course Contents

Introduction and scope, use of statistics in biology. Population and sample. Stages of research, types of data and methods of data collection. Data arrangement and presentation, formation tables and charts. Measures of central tendency computation of mean, median and mode from grouped and ungrouped data. Measures of dispersion, computation of variance, standard deviation, standard error and their coefficients. Probability rules. Binomial, poissons and normal distributions. Hypothesis testing, Student 't' test, Chi square test, Analysis of variance and LSD. Correlation and regression. Experimental designing, planning of an experiment, replication and randomization.

Books Recommended

1. Geoffery, R. Norman, David L. Streiner BIOSTATISTICS: THE BARE ESSENTIALS. 2000. B.C. Decke Inc.
2. Gerry, P. Quinn, Michael J. Keough, EXPERIMENTAL DESIGN AND DATA ANALYSIS FOR BIOLOGISTS. 2002. Cambridge University Press.
3. Campbell, R. C. STATISTICS FOR BIOLOGISTS. 1989. Cambridge University Press.

4. Zar, J. H. 2013. Biostatistical analysis 4rth Ed. Dorling Kindersley Publ. Inc.
5. Forthofer, R. N., Lee E. S., Hernandez, M. 2011. Biostatistics: A Guideto Design, Analysis and Discovery2nd Ed. Elsevier Inc.
6. Rao,K. V. 2009. Biostatistics: A Manual of Statistical Methods for Use in Health, Nutrition and Anthropology. Jaypee Brothers Publishers.
7. Quinn, G., P., Keough M. J.2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press.

ZOO-312	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 behaviour 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^{TH} 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.

ZOO-313	Cell and Molecular Biology	4 (3+1)

Course Contents

Objectives

The course aims to:

- Impart knowledge about the animal cell and its complex organization of architecture
- Provide understanding about the unified role of a cell for the ultimate sustainability of the organisms.
- Enable students to understand various ultra-structural, molecular and functional aspects of the cells will be communicated in this course.

Course Contents

Introduction to prokaryotic and eukaryotic cells: Plasma membrane**,** its chemical composition structure and functions of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis. **Cytoskeleton:** Microfilaments, Microtubules, Intermediate filaments.

Cytoplasmic Organelles: Membrane system, structural and functional commonalities. Ultrastructure, chemical composition and functions of Endoplasmic Reticulum and their role in protein synthesis and drug metabolism, Golgi apparatus its role in synthesis of glycoprotein, Mitochondrial respiration and its significance as semi-autonomous organelle; Lysosome, its diverse roles due to hydrolytic activity of enzymes, Peroxisome, its role in metabolism of hydrogen peroxide, Glycoxysome with reference to

glyoxylic acid cycle. **Nucleus:** chromatin, heterochromatin, euchromatin, chromosome structure, coiling and nucleosome during different phases of cell cycle.

Replication: mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes with emphasis on DNA polymerases, concept of replicons etc.,

Transcription: variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA with special reference to enzymes involved, RNA splicing, split genes, concept of ribozymes and posttranscriptional processing, RNA transduction, Genetic code, point mutations.

Translation: Specific role of Ribosomes, various factors, and posttranslational processing, control of gene expression in Prokaryotes.

Practicals

1.Identification of cell organelles

2. Preparation of temporary whole mount.

3.Preparation of permanent whole mount (demonstration)

4.Preparation of human blood smear and identification of Leucocytes.

5.Tissues (permanent slides of epithelial tissues, striated muscle, smooth muscle, cartilage, bone).

6.Squash preparation of onion root tip for mitotic stages.

7.Mounting of polytene chromosome (Drosophila/Chironomous.)

Demonstration.

8. Detection and quantitative determination of chromosomal DNA and RNA.

9. Cultural and staining of bacteria and yeast.

10. Separation of different sized DNA fragments on agarose gel.

11. Isolation and characterization of proteins on polyacrylamide gel electrophoresis (native and sub-unit molecular weights).

Books Recommended

1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K., Watson, J.D.2013. Molecular Biology of the Cell. Garland Publishing Inc., New York.
2. Damell Jr. J., Lodisch, H., Balimore, D. 2013. Molecular Cell Biology, Scientific American Inc. N.Y. 3.Friefelder, D. 2010. Molecular Biology.
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, Jhon Wiley and Sons, INC.
5. De Robertis, E. D. P., De Robertis Jr. E. N. F. 1987. Cell and Molecular Biology, Lea & Febiger, New York.

ZOO-314	Zoogeography and Palaeontology	3 (2+1)

Objectives:

The course aims to

- Provide information on the distribution of animals and their associations in the past and to rationalize their relationship in the present time.
- Impart knowledge and concepts of evolution mainly on the basis of fossil record.
- Give understanding that fossil record also provide information about the distribution of animals in the past eras.

Course Contents

(i). Zoogeography Branches of zoogeography: descriptive, chorology, faunistics, systematic, biocoenotic, causal, ecological, historical, experimental and applied zoogeography.

Animal distribution: cosmopolitan distribution, discontinuous distribution, isolation distribution, bipolar distribution and endemic distribution, barriers and dispersal.

Zoogeographical regions: zoogeographic division and boundaries, geographic ranges, physical features, climates, faunas and affinities of Palaearctic, Nearctic regions, Oriental, Ethiopian, Australian, and Neotropical Regions, insular fauna Palaeogeography: Theories of continental drift and plate tectonics; Pangea.

Zoogeography of Pakistan:

(ii). Paleontology

The Planet Earth: History, age, shells of earth; atmosphere, hydrosphere, biosphere and lithosphere.

Rocks: types; lgneous rocks, sedimentary rocks and metamorphic rocks.

Fossil types and uses of fossils, nature of fossils.

Fossilization: Geological time scale. Pre-Cambrian life. Post Cambrian life,

Palaeozoic life, Mesozoic life, Cenozoic life. Geochronometry: Uranium/Lead dating, radiocarbon dating, methods, index

fossils; evolutionary history of man, elephant, horse and camel, Paleoecology, Paleomagnetism.

Practicals

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.

Books Recommended

Zoogeography:

1. Beddard, F. E. 2008. A text book of zoogeography. Bibliobazar, LLC.
2. Tiwari, S.K. 2006. Fundamentals of world zoogeography. Wedams eBooks Ltd (India) Sarup & Sons. Delhi.
3. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
4. Darlington, P. J. Jr. 1963. Zoogeography, John Wiley and Sons.

Paleontology:

1. Michael, J. B. David, A and Haper, T. 2009. Paleobiology and the fossil record. 3rd Ed. Wiley Black, UK.
2. Foote, M and Millar, A. I. 2007. Principles of paleontology. 3rd Ed. W. H. Freeman & Co. USA.
3. Ali, S.S. 1999. Palaeontology, Zoogeography and Wildlife Management. Nasim Book Depot, Hyderabad, India.
4. Brouwer, A. 1977. General Palaeontology, Oliver and Boyed, London.

ZOO-311	Animal 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 behavioura; 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. Nortan 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.

University of Lakki Marwat Khyber Pakhtunkhwa 28420, Pakistan

Course outline
Department of Zoology
Program MSc Zoology 2nd Semester

Semester	Course code	Course title	Credit
Second	ZOO-321	Biological Techniques	3 (1+2)
	ZOO-322	Developmental Biology	4 (3+1)
	ZOO-323	Evolution and Principle of Systematics	3 (2+1)
	ZOO-324	Genetics	4 (3+1)
	ZOO-325	Research Methodology	2 (2+0)
		Total Credit hours	**16 (11+5)**

ZOO-321 Biological Techniques 3 (1+2)

Course Objectives:

1. The course aim to demonstrate the knowledge of biological skills
2. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
3. To develop basic understanding of the equipments handling/usage
4. To develop scientific technical expertise, culture and work habits.
5. To know how to collect and preserved animals

Course Learning Outcome:

After successfully completion of this course,

1. Students must be able to identify the instrument
2. Able to use instrument for identification, measurement, fixing and cutting of tissue
3. Able to apply a practical and research skill
4. Able to operate use the lab equipment efficiently.
5. Able to collect and preserved the specimen in dry and wet form.
6. Developed expertise in Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field

Course Contents:

1. Microscopy:

a. Principles of light microscopy. Magnification, Resolution,

b. Types of microscopy (Bright field, Dark field, Phase Contrast)

c. Confocal Microscopy

d. Electron microscope: Scanning electron microscope and Transmission electron microscope (SEM and TEM).

2. Standard unit system for weight, length, volume and Micrometery:

a. Different Measurement systems (length; surface; weight, volume, temperature), Calculations and related conversions

b. Concentrations- percent volume; ppt; ppm - molarity, normality, molality

c. Preparation of stock solutions of various strengths

d. Use of stage and ocular micrometers

e. Calibration of ocular micrometer and measurement of size animal and plant cell and nuclei

3. Specimen preparation for optical microscopy:

a. Introduction to Microtomy and its types

b. Tissue Fixation, dehydration, clearing, embedding, Section cutting (transverse, longitudinal section)

c. Tissue mounting (dry mount, wet mount)

d. Staining: Hematoxylin and Eosin staining

4. Separation and purification techniques:

a. Cell fractionation

b. Centrifugation and its types

c. Filtration and its types,

5. Chromatography:

a. Chromatography: Principle, applications, types,

b. Paper chromatography and thin layer chromatography

c. Column chromatography

d. High pressure liquid chromatography.

e. Electrophoresis: Principle, applications and types (Agarose and PAGE).

6. Spectrophotometry:

a. Principle, applications, types

b. Visible/UV spectrophotometry

7. Basic principles of Sampling and Preservation:

a. Sampling from soil, water, air, plants and animals

b. Preservation of dry and wet specimens.

c. Preservation techniques. lyophilization, preservation in ethanol, formalin etc.

8. DNA sequencing

a. Polymerase chain reaction (PCR), principle and application

b. DNA sequencing (Sanger and Maxam Gilbert).

Practicals:

1. Preparation of slides (dry mount and wet mount)

2. Observation of wet mounts of human cheek cells employing bright and dark field microscopy

3. Measurement of cell size: bacterial and eukaryotic Cell

4. Recording of microscopic observations with the help of camera lucida

5. Liquid handling: proper use of pipettes and micropittes

6. Hematoxylin and eosin staining

7. Gram's staining,

8. Handling of centrifuge machines

9. Paper Chromatography

10. Thin layer chromatography of amino acids

11. Spectrophotometric estimation of glucose

12. Collection and Preservation of representative animals of various phyla

Books Recommended:

1. Dean, J. R. 1999. Extraction Methods for Environmental Analysis. John Wiley and Sons Ltd. UK.
2. Cheesbrough, M. 1998. District Laboratory Practice in TropicalCountries. Part I. Cambridge University Press, UK.
3. Cheesbrough, M. 1998. District Laboratory Practice in TropicalCountries. Part II. Cambridge University Press, UK.

4. Curos, M. 1997.Environmental Sampling and Analysis: Lab Manual. CRC Press LLC. USA.

5. Curos, M. 1997.Environmental Sampling and Analysis: ForTechnician. CRC Press LLC. USA.

6. Slingsby, D., Cock, C.1986. Practical Ecology. McMillan Education Ltd. London.

7. Rob Reed/ David HOLMES, Jonathan Weyers/ Allan Jones Pearson, Practical skill in bio-molecular sciences.

8. Gallagher, S.R. and Wiley E.A. 2008. Current protocols essential laboratory Techniques. John Wiley & Sons Inc, USA.

9. Jones, A. Reed, R and Weyers, J. 1994. Practical skills in Biology. Longman Singapore Publishers (Pte) Ltd.

ZOO-322 Developmental Biology 4 (3+1)

Course Objectives:

The course aims to:

1. Provide information on transmission of traits from the parents in their gametes, the formation of zygote and its development.
2. Impart detailed knowledge about cellular basis of morphogenesis, mechanisms of cellular differentiation and induction.
3. Provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis.

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 Outline:

1. **Introduction**

a. History and Basic Concepts of developmental biology

b. Principal features of developmental biology and embryology with special emphasis on vertebrate models

c. Origin of sexual reproduction

d. Developmental patterns

2. **Spermatogenesis**

a. Mammalian spermatogenesis as model for all vertebrates

b. Spermiogenesis or (spermateliosis)

c. The role of Sertoli and Leydig cells in spermatogenesis

d. Hormonal control of spermatogenesis

3. **Primates Menstrual cycle**

1. Oogenesis

a. Mechanism of oogenesis among various classes of vertebrates.

b. Vitellogenesis

c. 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 extra embryonic 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:

1. Study of the structure of gametes in some representative cases, *i.e.* frog, fish and mammal.
2. Hen's egg internal and external structural details.
3. Microscopic analysis of hen's egg yolk, albumin and shell membranes.
4. Study of cleavage and subsequent development from prepared slides and/or models in various animals i.e., frog, mammals and chick etc.
5. Study of fertilization, early development of frog/fish through induced spawning under laboratory conditions.
6. Study of developmental stages of nematodes through microscopic analysis of animal dung.
7. Semen analysis
8. Dactylography and its uses in developmental biology

Books Recommended:

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

ZOO-323 Evolution and Principle of Systematics 3 (2+1)

Objectives

The course aims to:

- Provide in-depth knowledge of origin of life
- Develop concepts about forces responsible for evolutionary changes
- Study the importance and history of systematics with basic rules and regulations about the identification and naming of organisms.

Course Contents

(i). Evolution: The nature and origin to life: Evidences of evolution (molecular, embryological & paleontological).

Theories of Evolution: Theories to explain the diversity of life – Modern synthetic theory, factors initiating elementary evolutionary changes (micro-evolution) by changing gene frequencies, mutation pressure, selection pressure, immigration and crossbreeding, genetic drift.

Role of isolation in evolution: Factors of large evolutionary changes (macro/mega evolution) - allometry, orthogenesis, adaptive radiation.

Modern concept of Natural Selection: Levels of selection, selection patterns, laboratory and field example regarding action of Natural Selection. Action of Natural Selection leading to convergence, radiation, regression and extinction, Batesian mimicry, Mullerian mimicry, Sexual selection: Darwin's concept, Fisher's view, Zahavi's handicap theory, Recapitulation theory, Trend and rates in evolution.

(ii). Systematic Zoology Importance and applications of systematics: Taxonomy in Animal science, systematics as a profession and its future perspectives.

History of taxonomy: systematics, basic terminology of systematics, theories of biological classifications.

Taxonomic characters: Kinds and weightage, microtaxonomy, taxonomic categories: specific category, infraspecific category, higher categories; Species concept.

Typological species concept: Nominalistic species concept, biological species concept, Evolutionary species concept. Kinds of different species, Speciation, Taxonomic procedures, taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.

Systematics publications: International code of zoological nomenclature; its objective, principles, interpretation, application of important rules, with reference to: Zoological nomenclature, law of priority and validity of names.

Practicals

1. Study of preserved invertebrate species and their classification up to class level.
2. Collection, preservation and identification of common species with the help of keys.
3. Preparation of keys for the identification of specimens.
4. Methods of statistical analysis of samples from populations T-test, Analysis of variance etc.

Books Recommended

Evolution

1. Strickberger. M.W. 2012.Evolution.Jones & Barrett Publishers.
2. Ridley, M. 1993. Evolution. Blackwell Scientific Publications.
3. Moody, P.A. 1989. Introduction to Evolution, Harper and Row Publishers, New York.
4. Dobzhansky, T., Ayala, F.J., Stebbins, G.L., Valentine, J.W. 1973. Evolution. W.H.
Freeman and Company.
5. Mayr, E. 1965.Populations, Species and Evolution, Harvard University Press.

6. Dobzhansky, T. 1951. Genetics and the origin of species. Columbia University Press, New York.

Systematic Zoology

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

2. Mayer, E. Principles of Systematic Zoology. 1994. McGraw Hill, New York.

3. Mayer, E. and Asblock, P.D. Principles of Systematic Zoology. 1991. McGraw Hill, NY.

4. Mayr, E. Animal Species and Evolution, 1985.Harvard University Press.

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

6. Whili, M.J.D. Modes of Speciation, 1978. W.H. Freeman and Co., San Francisco.

ZOO-324	Genetics	4 (3+1)

Course Objectives:

1. To understand the terms and basic concepts of genetics, providing a conceptual framework for future reference.
2. To provide understanding about the continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc.
3. To develop the concept that continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment.
4. To understand how traits are inherited and to use this understanding in analyses (to solve problems and complete pedigrees).
5. To understand probability concepts and use these concepts to solve problems (including basic statistical problems).
6. To understand how genetic problems may lead to disease or lethality.
7. To understand the molecular basis of genetics (including such topics as replication, transcription, translation, and mutation).
8. To understand mechanism of repair and molecular genetic analysis.
9. To understand the workings and importance of major genetics techniques such as PCR.
10. To understand current issues regarding genetics (e.g., cloning, use of transgenic organisms).
11. To understand Mendelian and non-Mendelian pattern of inheritance in human.
12. To understand the workings and uses of population genetics technique.

Course Learning Outcome

1. Able to define terms of genetics and apply concepts of modern transmission

2. Identify and describe the process and purposes of the cell cycle, meiosis, and mitosis, as well as predict the outcomes of these processes.
3. Solve transmission genetics problems, make accurate predictions about inheritance of genetic traits, and map the locations of genes.
4. Identify the parts, structure, and dimensions of DNA molecules, RNA molecules, and chromosomes, and be able to categorize DNA as well as describe how DNA is stored.
5. Able to accurately draw the diagram and describe the processes of replication, transcription, translation, as well as predict the outcomes of these processes.
6. Describe what causes and consequences of DNA sequence changes and how cells prevent these changes, as well as make predictions about the causes and effects of changes in DNA.
7. Describe the processes of gene regulation and predict how a gene will be expressed under specific circumstances.
8. Learn and practice common genetics laboratory techniques.
9. Describe applications and techniques of modern genetic technology, as well as select the correct techniques to solve practical genetic problems.
10. Carry out genetics laboratory and research techniques.
11. Identify the human traits and genetic diseases.
12. Describe experimental results in written format both informally and in formal manuscript format
13. Able to solve problem related to population genetics.

Course Contents:

1. **Introduction**

a. Classical, molecular and population Genetics: Scope and importance of genetics, Forward and reverse genetics. The basic principles of Inheritance (Mendelism):

Monohybrid and Dihybrid crosses (Definition - characteristics criss-cross inheritance).

b. Multiple Alleles: blood groups and coat color in rabbits.

c. Genetics of Rh factor and Erythroblastosis Foetalis.

2. **Chromosomal Basis of Inheritance:**

a. Chromosomal theory of inheritance

b. Interaction of genes, Epistasis, Lethality and Pleiotropism.

3. **Chromosomal Aberrations**

a. Changes in chromosomal number, Euploidy, aneuploidy (Klinefelters syndrome, and Turners syndrome, Down syndrome and Edwards syndrome).

b. Structural changes, insertion, deletion (Cri du chat syndrome), duplication,

c. Inversion and translocation

4. **Pedigree Analysis:**

a. Normal human chromosome complement; Karyotyping.

b. Sex-determination and Sex-linkage:

c. Sex determination in animals and humans,

d. Sex linked (Hemophilia, muscular dystrophy, and color blindness), sex influenced and sex limited traits,

e. Prenatal Diagnosis: Amniocentesis and choriovillus sampling - Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics

5. **Chromosome mapping**

a. Linkage, recombination (crossing over) and

b. Chromosome mapping in eukaryotes.

6. Molecular Genetics:

a. Gene Concept (classical and modern),

b. Genetics of Viruses and Bacteria,

c. Transposons,

d. Mutation and DNA repair

e. Molecular Genetic Analysis,

f. Regulation of Gene Expression in Prokaryotes,

g. Gene Regulation in Eukaryotes,

h. Genetic basis of diseases, like cancer,

i. Genetic control of animal development.

j. The genetic control of the Vertebrate Immune System,

7. **Recombinant Technology**

a. The Techniques of Molecular Genetics (elements of genetic engineering),

b. PCR

8. Human Genetics;

a. Single and Multifactorial Disorders:

b. Autosomal anomalies, Pseudoautosomal genes,

c. Single gene disorders: Gene mutation and disorders; autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as Phenylketonuria, alkaptonuria).

d. Complex Inheritance Patterns, Polygenic traits- Cleft lip and cleft palate.

9. Population Genetics:

a. Hardy-Wienberg equilibrium,

b. Systematic and Dispersive pressures, 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 counselling

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 Ins. 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. Concepts of Genetics By Klug, W.S and Cummings M.R.
8. Willium 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-10:1449659853.
10. Gene- XI by Lewin's,2013,ISBN:978-1449659851
11. Concepts of genetics 11th edition, William S.Klug,2014,ISBN-13:978-0321948915.

ZOO-325	Research Methodology	2 (2+0)

Objectives

The course is aims to:

- Develop research skills
- Provide understanding how to design scientific research , to collect data and its interpretation
- Emphasize the importance of ethics in scientific research
- Enable students to write a research proposal.

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. **Aim and Objectives:** 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

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

Text and Reference Books:

1. Paul Leedy, 2004, Practical Research: Planning and Design (8th Edition), Jeanne Ellis Ormrod.
2. Creswell, J. W. (2013). Research Design Quantitatvive Qualitative and Mixed Methods Approaches. Sage.
3. Hess-Biber, S. N. and P. Leavy. (2004). Approaches to Qualitative Research, A Reader on Theory and Practice. New York, Oxford University Press.
4. Khan, J.A. (2008). Research Methodology. New Delhi: APH Publishing.
5. Kothari, C.R., & Gaurav, G. (2014). Research Methodology: Methods and Techniques. New Delhi: New Age International.
6. Kumar, R. (2011). Research Methodology: A Step By Step Guide for Beginners. Cornwall: SAGE Publications, Inc.
7. Laurel, B. (2003). Design Research, Methods and Perspectives. London England, The MIT Press.

University of Lakki Marwat Khyber Pakhtunkhwa 28420, Pakistan

Course outline
Department of Zoology
Program MSc Zoology 3rd Semester

2nd Year (3rd Semester)			
S. No	**Course category**	**Course Title**	**Cr. Hrs**
1	ZOO-433	Environmental biology	4 (3+1)
2	ZOO-431	Animal Physiology	4 (3+1)
3	ZOO-435	Wildlife	2 (2+0)
4	ZOO-434	Parasitology-I	4 (3+1)
5	ZOO-432	Entomology	3 (2+1)
Total credits			**17 (13+4)**

ZOO-433 Environmental Biology 4 (3+1)

Objectives

The main goal of this course is to:

- Enable students to develop strong expertise in contemporaneous themes in ecological research
- Develop critical thinking and to discuss about advanced topics in population, community and ecosystem ecology as well as in biodiversity research.
- Develop expertise to update their knowledge continuously, and to design their own research in ecology.

Course Contents:

Energy: laws of thermodynamics, primary and secondary productions, trophic levels and energy variation with increasing trophic levels, energy flow, food chains and food webs. Biogeochemical cycle: nitrogen,

phosphorus, sulpher, water, carbon, nutrient. Limiting factors: basic concepts, temperature, soil, water and humidity, light, fire.

Ecosystems: (atmosphere, hydrosphere, lithosphere, ecosphere). An overview of ecosystem with special reference to ecological niche: basic concepts and types. Major ecosystem of world: Marine, Estuarine,

Freshwater, Wetlands, Tundra, Forest, Grassland, Desert and Agricultural ecosystems.

Population ecology: basic population characters, growth and growth curves, population dynamics and regulations. Community ecology: basic concepts, community analysis, ecotones, inter-population interactions.

Applied Ecology: resources and their ecological management (mineral, agricultural desalination and weather modification, forest and range management, landscape and land use);

Pollution: (definition, types, cost, origin and management); water (sources, domestic and industrial pollution, heavy metals); air (sulpher dioxide, nitrogen oxide, carbon monoxide, ozone, smog and PAN, MTBE & CFCs); land pollution (pesticides, bacterial toxins, synthetic hormones); noise pollution.

Radiation ecology: global environmental changes (ozone depletion, acid rain, greenhouse effect and global warming, Koyota protocol, desertification, deforestation, exotic and invasive species, radioactivity

leakage, environmental laws).

Practicals

1. Measurement of environmental factors on land, water and air.
2. Study of different ecosystems: pond, agricultural or grassland, forest.
3. Community analysis through different sampling techniques (quadrat, Transect),
4. Population studies mark and recapture method, statistical analysis of field data.
5. Adaptive features of animals in relation to food and environment.
6. Food chain studies through analysis of gut contents.
7. Analysis of polluted and fresh water for biotic and abiotic variations.
8. Field visits for study of selected terrestrial habitat and writing notes.
9. Experimental design and approaches in ecological research; writing a research project
10. Development of an ecological management plan of some selected area.

Books Recommended

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

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

ZOO-431	Animal Physiology	4 (3+1)

Objectives

The course aims to

Provide information about the physiological mechanisms underlying animal functions.

Enable students to understand neuro-endocrine coordination, physiology of heart, hemodynamics and kidney function.

Impart information on respiratory function and gut physiology

Give understanding about the mechanism of homeostasis, physiological regulation of

temperature and its maintenance

Course Contents

Central themes in Physiology: Homeostasis, Concepts of conformity and regulation; physiological adaptations. Membrane Physiology: Ionic distribution across membrane, Resting membrane potentials: Electrogenic ion pump, Donnan equilibrium, Ion channels Nerve and Muscle Physiology: Action potentials in neurons; Electrical and chemical synaptic transmission; Neurotransmitters; Excitatory and inhibitory postsynaptic potentials; tetany; Muscles: Structure, types, components, muscle proteins, molecular basis of muscle contraction: sarcoplasmic reticulum and role of calcium, muscle action potentials, isometric and isotonic contraction, leverage factor, muscle fatigue.

Receptors Physiology: Receptor types: Mechanoreceptors, Olfactory and taste receptors, Photoreceptors, Photochemistry and Phototransduction; acoustico-lateralis system, Cutaneous receptors, electro-receptors. Sensory transduction, coding and adaptations. Range fractionation. **Endocrine Physiology:** Gland types; Hypothalamus, Pituitary, Thyroid, Parathyroid, Pineal, Pancreatic Islets, Gastric glands, Adrenal, Ovary, Testis and Placenta; Overview of hormones; types, peptide

and steroid hormones, chemistry, synthesis and roles. Hormone receptors and signal transduction. Feedback mechanisms.

Cardiovascular Physiology: Electrical activity of heart: Autorythmicity, Electrocardiography, Kymography; Hemodynamics, Relationship between blood flow, pressure and resistance. Control of cardiac activity, cardiac output and peripheral circulation.

Respiratory Physiology: Respiratory epithelia, gas exchange in gills and lungs; Transport of O2 and CO2, Structure of alveoli, lung volumes and capacities, surfactants, control of breathing; hypoxia; Hypercapnia etc., air breathing in divers.

Renal Physiology: Osmoregulation: Osmoregulation in aquatic and terrestrial animals; Kidney and Vertebrate nephron as osmoregulatory and excretory organ: Glomerular filtration, Tubular absorption and secretion; Nitrogenous waste products; Patterns of nitrogenous excretion and their phylogenetic significance.

Physiology of Digestion: Physiologic anatomy of digestive tract (mammalian model), Regulation of digestive secretions; Absorption of water, ions and nutrients; Potential and Movements in gastrointestinal tract; Control of motility. Deglutition, Peristalsis, Absorption, Assimilation and defecation.

Temperature Regulation: Temperature classification of animals; Temperature relation of ectotherms in freezing and cold and warm and hot environment; Costs and benefits of ectothermy; Temperature relations of heterotherms and endotherms; Dormancy: Sleep, Torpor, Hibernation and Estivation.

Practicals

1. Determination of haemoglobin content, haematocrit and cell counting. Preparation of blood smears.
2. Nerve muscle preparation, Muscle twitch, Comparison of muscle and nerve irritability, effect of stimulus strength, effect of stimulus frequency (tetany),

effect of load or stretch, effect of prolonged activity (fatigue), neuromuscular fatigue, stimulation of motor points in human.

3. Recording of action potential by oscilloscope and demonstration of its various features. Experiments to demonstrate characteristic of reflex arc. Experiment in human (students themselves) to demonstrate some aspect of sensory physiology.
4. Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.
5. Oxygen consumption in fish and effect of temperature (by dissolved oxygen meter) and terrestrial animal (mouse). Oxygen consumption (by respirometer), heart rate, blood pressure glycemia altered by exercise.
6. Effect of insulin on glycemia, study of stages in estrous cycle.

Books Recommended

1. Guyton, A.C., Hall, J.E. 2013. Textbook of Medical Physiology, 10th Ed. W.B. Saunders Company, Philadelphia.Sherwood 2013.
2. Tharp, G., Woodman, D. 2010. Experiments in Physiology, 10th Ed. Bejamin Cummings.
3. Fox, S. 2010. Laboratory manual of human physiology. McGraw-Hill Sciences
4. Randall, D., Burggren, W., French, K., Fernald, R. 2002. Eckert Animal
5. Physiology: Mechanisms and Adaptations, 5th Ed. W.H. Freeman and Company, New York
6. Bullock, J., Boyle, J., Wang, M.B. Physiology, 4th Ed. 2001. Lippincott, Williams and Wilkins, Philadelphia.
7. Berne, R.M., Levy, M.N. 2000.Principles of Physiology, 3rd Ed. St. Lious, Mosby.

8. Withers, P.C. 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
9. Schmidt-Nelsen, K. 1997. Animal Physiology, Adaptation and Environment, 5th Edition. Cambridge University Press, Cambridge.

ZOO-435	Wild Life	2 (2+0)

Course Objectives:

The objective of this course is

1. To enable the student to understand philosophy and significance of wildlife conservation
2. To understand the wildlife management rules and regulations in Pakistan
3. To understand how National and International agencies are involved in conservation and management of wildlife

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
5. **EVALUATE** the conservation management by government department, National and International organizations.
6. **DEMONSTRATE** the ecological assessment and importance of wildlife to certain area.

Objectives

The students will learn:

About wildlife, distribution pattern world over

Regarding wildlife of Pakistan, threatened, endangered species

Modern techniques used in animal tracking, data collection

How to protect, maintain, control and preserve the health and environment of wildlife.

Course Contents

Wildlife: Animal occurrence, protection, needs of animals, maintenance, and the habitat.

Techniques: Ground and aerial tracking, GPS, radiotelemetry, maps etc.

Wildlife Conservation: Philosophy and significance, Biodiversity and sustainability of wildlife.

Wildlife Agencies: National and International agencies involved in conservation and management of wildlife. International conventions, agreements.

Wildlife of Pakistan: identification, distribution, status, conservation and management (population estimate technology) of fishes, reptiles, birds and mammals of major importance in Pakistan.

Wildlife rules and regulations in Pakistan: Sanctuaries, Game Reserves and National Parks in Pakistan. Endangered species of Pakistan.

Books Recommended

1. Ali, S.S. 1999. Paleontology, Zoogeography& Wildlife Management. Nasim Book Depot. Hyderabad, India.
2. Roberts, T. J. 1998. *The Birds of Pakistan*, (Vol. II), Oxford University Press.
3. Roberts, T. J. 1992. *The Birds of Pakistan*, (Vol.I). Oxford University Press.
4. Magon, C.F. 1988. *Biology of Freshwater Ponds*. Longman and Scientific Publication.
5. Bailey, J.A. 1986. *Principles of Wild life Management*. John Wiley and Sons.
6. Robinson, W.L., Bolen, E.G. 1984. *Wildlife Ecology and Management.* McMillan, Cambridge.

7. Roberts, T.J. 1977. *Mammals of Pakistan*. Ernest Benon Ltd, London.
8. Ali S., Ripley S. D. 1973. *A Handbook of Birds of India & Pakistan*, Oxford University Press, London.
9. Elirza Z.B, the Birds of Pakistan.

ZOO-434	Parasitology-II	4 (3+1)

Objectives

This course will

•Introduction to general Parasitology

•provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance

•knowledge about their pathology, host parasite relationship and control measures

Course Contents

Introduction to parasitology. Relationship to other sciences, parasitology and human welfare. Parasites of domestic and wild animals. Camers in parasitology. Some basic definitions. Basic principles and concepts.

Parasite ecology and evolution. Basic principles and concepts. Immunology and pathology. Susceptibility and resistance, innate defence mechanisms.

Acquired immune response in vertebrates. Immunity in invertebrates.

Immunodiagnosis, pathogenesis of parasitic infections. Accommodation and tolerance in the host-parasite relationship.

Parasitic protozoa, form, function and classification: Kinetoplasta, trypanosomes and their kin, forms of trypanosomatidae. Other flagellated protozoa, order Retortamonadita, order Diplomonadida, order Trichomonadida, order Opalinida. The Amoebas. Order Amoebida, order Schizopyrenida. Phylum Apicomplexa, Gregarines, Coccidia and related organisms. The apical complex, class Gregarinea, class Coccidea. Phylum Apicomplexa, Malana, organisms, and pyroplasms, order Haemospondea, order Pyroplasmida. Phylum ciliophora, ciliated protistan parasites, class Spirotoichea, class Litostomitea, class Oligohymenophorea. Phyla Microspora and Myxozoa.Parasites with polar filaments. Phylum Microspora, Phylum Myxozoa. The Mesozoa, pioneers or Degenerates.

Practicals

1. Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance.
2. Section cutting of the infected tissues and the study of their pathology.
3. Methods of collection, preservation and transportation of parasitic material.
4. Qualitative and quantitative faecal examination for helminth ova.
5. Collection, preservation and preparation of slides of local helminthes and their identification.
6. Identification of insects of medical and veterinary importance.

Books Recommended

1. Roberts, L.S. and Janovy, J. Jr. 2005. Foundations of Parasitology. 7th Edition. W.M. Brown Publishers, Chicago, London, Tokyo, Toronto.
2. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W. 2000. Veterinary Parasitology. Longman Scientific and Technical publications, Longman Group, UK.
3. Roberts, L.S. and Janovy, J. 2000. Foundation of Parasitology, 6th Edition. McGraw Hill Book Co.
4. Hausman, K. and Hulsmann, N. T. 1996. Protozoology, 2nd Edition. Medical Publishers, Inc. New York.
5. Smyth, J.D. Introduction to Animal Parasitology. 1994. Cambridge University Press.
6. Cheesbrough, M. 1987. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge.
7. Noble, E.R. and Noble, G.A. Parasitology. 1982. The Biology of Animal Parasites. 5th Edition. Lea and Febiger Publisher.
8. Beck, J.W. and Davies, J.E. 1981. Medical Parasitology. 3rd Edition. C.V. Mosby Company, Toronto, London.

ZOO-432	Entomology	3 (2+1)

Course Contents

Introduction to Entomology, Position of insect in animal kingdom, general characteristics of insects.

Hard Parts: General segmentation, tagmatosis and organization.

Cuticle: Detailed structure along with its biochemistry. Epidermal layer; its structure and function. Basement membrane. Colours of insects. Cuticular outgrowths and appendages sclerotization.

Head: cephalization, sclerites, modifications.

Antennae: Different types of antenna and their structure.

Thorax: Sclerites: legs, their different modifications and functions.

Wings: Origin; Different regions. Development and basal attachments, main veins and their branches (generalized insects), wing coupling.

Abdomen: General segments of abdomen of Insect. Flight; types of flight. Aerodynamics, fuels, endoskeleton; head, thorax and abdomen.

Soft Parts: General account of Insects Muscular system. Basic structure of Insects muscle, types of muscles. Muscle contraction and its energetics,

Digestive system: Comparative structure of the digestive system and their physiology.

Respiratory System: Comparative structure of the respiratory System and their physiology.

Nervous system: Incubatory, and nervous system and their physiology.

Excretory System: Comparative structure of the excretory system and their physiology.

Reproduction: Reproductive organs and different types of reproduction in insects. Egg fertilization and maturation.

Development: Embryology up to dorsal closure,

Sense organs: sound producing organ and types. light producing organ.

Endocrine system: Exocrine and endocrine glands of insects. Pheromones and their functions.

Metamorphosis: Different types of metamorphosis.

Insects defence: Insect defences and adaptations. Prey-predation and competition in Insect.

Ecology: Carrying capacity ‘r’ and k selection, Food chains, predation and competition, insect defenses and adaptations, diapause insect population and community studies, insect communication.

Practical:

1. Preparation of permanent slides. All the hard parts (antennae, mouth parts, wings, legs, terminal segments and genitalia).
2. Different systems, especially digestive, reproductive of the following insects. American cockroach, Gryllus, grasshopper, housefly, butterfly, mosquito, any common beetle. Red cotton bug. Wasp and honey bee.
3. Sympathetic nervous system of cockroach and gryllus. Salivary glands of cockroach, red cotton bug and honey bee.

Books Recommended

1. Chapman, R.F. The insects: structure and function. 2000. Blackwell Science Inc., London.
2. Krebs, C. J. Ecology: the experimental analysis abundance. 5th Edition. 2000. Benjamin-Cummings Publishing Company.
3. Price, W. Insect ecology. 1997. John Wiley & Sons.
4. RICHARDS, O. W. and DAVIES, R. G. IMM'S General Textbook of Entomology. Vol.1, 10th Edition. 1977. Chapman & Hall, London.
5. Robert L. Patton. W. B. Insect Physiology. 1963. Saunders Co., Philadelphia.
6. Southhood, T.R.E. Ecological Methods. 1978. Chapman and Hall, London.

7. Tembhare, Db. Modern Entomology. 2002. Himalaya Publishing House. India.
8. Wigglesworth, V. B. Insect Physiology 8th Edition. 1984. Springer Publisher.
9. Yazdani, S.S., and Agarwal, M.L. 1997. Elements of insect ecology. Narosa Publishing House. India. 10. Sakis Drosopoulos, Michael F. Claridge, 2005, Insect Sounds and Communication: Physiology, Behaviour, Ecology, and Evolution Contemporary Topics in Entomology, Illustrated edition. Publisher CRC Press.
10. Gordon Gordh, Contributor David Headrick, 2011, A Dictionary of Entomology. Publisher CABI.

University of Lakki Marwat Khyber Pakhtunkhwa 28420, Pakistan

Course outline
Department of Zoology
Program MSc Zoology 4th Semester

Semester	Course code	Course title	Credit
Fourth	ZOO-441	Applied Entomology and Pest Management	3 (2+1)
	ZOO-442	Applied Fisheries	4 (3+1)
	ZOO-443	Bioinformatics	3 (1+2)
	ZOO-444	Immunology	4 (3+1)
	ZOO-445	Parasitology-II	4 (3+1)
		Total Credit hours	**18 (12+6)**

ZOO-441 Applied Entomology and Pest Management 3 (2+1)

General account on the classification, insect classification; Classification and characteristics of insect order: Collembola, Orthoptera, Dictyoptera , Isopetra , Hemiptera , Lepidoptera, Diptera, Hymenoptera, Coleoptera. Diagnostic features of the remaining insect order. insect of economic importance; Biological control of insects; Chemical control of insects; concept of IPM; Method of IPM; sampling techniques in insect pests.

Practical:

1. Collection, Preservation and identification of insects up to families with the help of literature/keys.
2. Identification of important insect face up to species level.
3. Survey and field visit.
4. Pest monitoring of important insect pests in the field.
5. Knowledge of insect pests of
   a) Rice
   b) Cotton
   c) Sugarcane
   d) Wheat

Brief account of different insect pest management strategies as:

a) Culture control
b) Physical and mechanical control
c) Host plant resistance
d) Biological control
e) Chemical control
f) Other approaches

Practical:

1. Field visits for collection of different developmental stages of insects belonging to different orders.
2. Identification and classification of collected specimens.
3. Field visits and report writing of insects fauna of different crops.
4. Field visits for survey of different control strategies being practiced for control of insect pests.
5. Museum visits

Text Book:

Entomology and pest management, 1991 by pidego,I.

Suggested Reading

1. The Insects, an outline of Entomology, 2010 by penny J. Gullan and Peter S. Cranston
2. The principles of Insect physiology, 1977, by Wigglesworth

ZOO-442	Applied Fisheries	4 (3+1)

Theory

Basic principle of fish culture: Extensive fish culture, semi intensive fish culture, intensive fish culture.

Construction and Management of Fish Farm: ponds for fingerlings, Ponds for yearlings, Rearing ponds, Nursery ponds, fattening ponds, stocking ponds, Farm for large scale fish calture.

Construction and maintenance of fish seed hatchery: Hatchery for salmonids, Hatchery for eyprinids , Hatchery for Catfishes

Natural food and feeding: phytoplankton, zooplankton, crustaceans, Arthopods larvae, annelids, molluscs

Artificial feed and feeding: of plant origin, of animal origin, feed for salmonids,feed for cryprinids, feed pelleting, adaptation of fish on petted feed

Breeding and cultivation of salmonids (rainbow trout and brown trout): Natural breeding, artificial breeding, induced spawning, hormonal induced spawning.

Breeding and cultivation of Cyprinids (major carps Chinese carps): Natural breeding, artificial breeding, induced spawning, hormonal induced spawning.

Fish Diseases and Their Control: Viral diseases, bacterial diseases, fungal disease, parasitic (protozoan helminths, crustaceans, leeches, argulus etc.)

Fish Enemies and their control: Amphibians, Reptiles, birds, mammals, chemical and fertilizers.

Pound fertilization and its significance: varieties of organic and inorganic fertilizer, doses of fertilizer, and its uses.

Common freshwater aquatic weeds and control: Biological, chemical, mechanical fish harvesting and marketing: netting transportation maintenance of flash quality and price control

Practical.

1. Morphological identification of important culturable fish species
2. Study of gut contents of culturable fish species
3. Diagnosis of important bacterial disease in Cyprinids
4. Study of Important parasites of fish
5. Stripping of mature fish and artificial fertilization of eggs and sperms
6. Study of early developmental stages
7. Visit to various fish seed hatcheries during fish breeding season.

Books recommended

1 . Moyle, P.B and Joseph, J.C.2004. Fisheries: An introduction to ichthyology, prentice Hall, London.

2. Parker R. O., 2004, Aquaculture science 1+th ed). Delmar Learning Landon.

3. Kestin, 2001. Farmed fish Quality Multiline books.

4. Ruth, 2000. Freshwater aquaculture multiline books.

ZOO-443	Bioinformatics	3 (1+2)

Course Objectives

The course will provide:

1. An introduction to bioinformatics.
2. To develop awareness about fundamental bioinformatics databases.
3. Information on the tools used to compute solutions to those problems, and the theory upon which those tools are based.

Course Outcomes:

Upon successful completion of the course, the students should be able to:

1. **GAIN** an understanding of the basic concepts of Bioinformatics.
2. **EXPLAIN** the basics of bioinformatics and computational biology.
3. To **USE** bioinformatics search tools on the internet for mining data, pairwise and multiple sequence alignments and predict protein structures.

Course Contents:

1. Introduction:

a. Introduction to Bioinformatics, Scope of bioinformatics, useful websites.

b. Aims of bioinformatics, disciplines related to bioinformatics, major tasks involved in bioinformatics analysis, bioinformatics tools

c. Short introduction to proteomics and genomics, and the role of bioinformatics in the pharmaceutical industry.

d. Human genome project

2. Biological databases

a. Data and types of data, data acquisition

b. Major DNA databases around the world, NCBI, BOLD, DDBJ and EMBL

c. Major protein databases in the world, protein sequence databases, protein structure databases

d. Specialized databases, genome and organism databases

e. Non sequence databases, PubMed, PubMed health, OMIM

3. **Short introduction to DNA/RNA**: structure, genetic code; analyzing the DNA/RNA sequence by the use of BI tools.
4. **Genome mapping**

a. Genetic and linkage mapping, physical mapping

5. **Gene family**:

a. Introduction, types, protein family, Globin family as an example, globin genes and chains, evolution of globin proteins in human, combination and types of globin proteins in human.

6. **Data Retrieval:**

a. Searching sequence databases

b. FASTA format

c. Retrieval of nucleotide sequence data, retrieval of protein sequence and structure data, retrieval of literature and map data

7. **Primer Designing:**

a. Primer and probe, qualities of primer, general rules for primer designing.

b. Websites used for primer designing (PRIMER3+, PRIMER-BLAST, OLIGO-CALC etc.)

8. **Sequence Alignment:**

a. Importance and significance of alignment, methods for sequence alignment

b. Local and global alignment, pair-wise local alignment

9. **BLAST:** Introduction, types, uses, algorithm, BLAST Scores
10. **Multiple Sequence Alignment:**

a. Introduction, tools for MSA, uses and importance

11. **Phylogenetic analysis:**

a. Introduction, interpretation, rooted and unrooted tree,

b. phylogenetic methods, tree terminology, comparison of methods, software

Practicals/Tutorials:

1. Introduction to NCBI
2. Retrieving Literature from NCBI
3. Classification of an organism using NCBI
4. Retrieving FASTA sequence for nucleotide and protein
5. Retrieving disease gene information
6. Searching gene families
7. Primer Designing
8. BLASTing a nucleotide / amino acid sequence
9. Multiple Sequence Alignment using different amino acids / nucleotide sequences
10. Phylogenetic Analysis of different nucleotide / amino acid sequences
11. Microarrays data retrieval from the web

Text and Reference Books:

1. Baxevanis, A.D., Ouellette, B.F.F. (2011) Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. John Wiley & sons, Inc.

2. Rastogi, S.C., Mendiratta, N., Rastogi, P. (2011) Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. PHI publishing.

3. Pevsner, J. (2015) Bioinformatics and Functional Genomics. 3rd Edition. Willey-Blackwell

4. Lesk, A. (2014) Introduction to Bioinformatics. 4th Edition. Oxford University Press

5. Selzer, P., Marhofer, R. and Rohwer, A. (2008) Applied Bioinformatics: An Introduction. Springer publishing, Germany.

ZOO-444	Immunology	4 (3+1)

Course Objectives:

The objectives of the course are:-

1. To be able to clearly state the role of the immune system and a foundation in immunological processes

2. To provide students with knowledge on how the immune system works building on their previous knowledge from biochemistry, genetics, cell biology and microbiology

3. The students will be able to describe immunological response and how it is triggered and regulated.

Course Learning Outcomes:

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

1. Explore the basic knowledge of immune system

2. Describe the concepts of how the immune system works.

3. Interpret the problems using immunological techniques for diagnosis of immune disorders.

4. Identify the problems usingimmunological diagnostic tools.

5. Detect the problems using the same techniques for other disorders.

6. DEMONSTRATE individually the ELISA and other Assays/Tests.

Course Outline:

1. Introduction

a. Introduction to immunity.

b. Immune response

c. Infectious agents

2. Innate Immunity and Inflammation

a. Sentinel cells and circulating leukocytes

b. Inflammatory events and signalling

c. The formation of pus

3. Microbial Recognition and Responses in Innate Immunity

a. Pattern recognition receptors

b. Innate immune signalling

c. The complement system

4. Antibodies

a. B lymphocytes

b. Antibody structure and function

5. Lymphocyte Development and Diversity

a. Lymphocyte development

b. Clonal selection and expansion

c. Differences between B and T lymphocytes

d. The generation of lymphocyte receptor diversity

6. T Cell Activation by Antigens

a. The role of dendritic cells

b. The lymphatic system and delivery of antigen to lymph nodes

c. Adaptive immune activation in secondary lymphoid tissues

d. Antigen presentation

7. T Cell-Dependent B Cell Responses

a. T Cell activation of B cells

b. Isotype switching and affinity maturation

8. Helper T Cells

a. Helper T cell functions

b. The role of helper T cells in disease

9. Cytotoxic T Cells

a. Cytotoxic T cell functions

b. Selection and expansion of cytotoxic T cells

c. Therapies that target cytotoxic T cell functions

10.Failures of the Immune System

a. Immunodeficiencies

b. Autoimmune diseases

c. Allergic diseases

11. Immunology-Based Therapy of Diseases

a. Transplantation and transfusion

Practical:

1. Antibody Purification and Conjugation
2. Immunofluorescence
3. Gel Techniques
4. ELISA
5. SDS PAGE/Western blots.

Text and Reference Books:

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular Biology of the Cell (5th ed. 2008, Garland)
2. Thomas J Kindt, Richard A Goldsby, Barbara A Osborne, Janis Kuby: Immunology (2003, Freeman). 3. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt Roitt: Roitt's Essential Immunology (12th ed. 2012, Blackwell)
3. Abul Abbas , Andrew H. Lichtman, Shiv Pillai. Cellular and Molecular Immunology , 9th edition, 2017. Elsevier Pub Co.
4. Gerd R. Burmester, Antonio Pezzutto Color Atlas of Immunology, 2006. Thieme Stuttgart, New York.

ZOO-445	Parasitology-II	4 (3+1)

Theory:

Systematics, biology, pathology, host parasite relationships and control of parasitic Helminths with particular reference to Helminths of Medical and Veterinary importance. Systematics, morphology and biology of Arthropods causing disease or those responsible for transmission of disease. Chemical and non-chemical control of Arthropods of Medical and Veterinary importance.

Helminthology

a. Helminth parasites of man and other animals
b. General account, classification, biology, life cycle, pathology and symptology and immunology of Platyhelmenthes: e.g. Trematodes (Fisccciola and Schistosoma) Cestodes: Taenia. Nematodes: Trichuris, Strongyloides, Toxocara and Filaria worms.

Medical and Veterinary Entomology

a. Biology and classification of arthropods of veterinary and medical importance.
b. Biology and life cycles e.g. lice, Ticks, mites, mosquitoes, fleas, flies, bugs etc.
c. Arthropods as disease transmitters/vectors.

Practical

1. Methods of collection, preservation and transportation of parasitic material.
2. Qualitative and quantitative faecal examination for helminthic ova.
3. Collection, preservation and preparation of slides of local helminthes and their identification.
4. Identification of insects of medical and veterinary importance.

Books Recommended:

1. Noble and Noble, 1982. Parasitology. The Biology of animal parasites. 5th Ed.. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical parasitology. 3'd Ed.. The C.V. Mosby Company, Toronto, London. Cheesbrough, M., 1987.
3. Medical Laboratory Manual for Tropical Medicine. Vol.I. University Press Cambridge. Smyth, J.D., 1994.
4. Introduction to Animal Parasitology. Cambridge University Press.