

COURSES OF STUDY
FOR
M.Sc. (ANNUAL SYSTEM)
2 YEAR PROGRAMME
IN
ZOOLOGY



**GOVERNMENT COLLEGE UNIVERSITY,
FAISALABAD**

Website: www.gcuf.edu.pk

**DEPARTMENT OF ZOOLOGY,
GOVERNMENT COLLEGE UNIVERSITY, FAISALABAD.**



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**DEPARTMENT OF ZOOLOGY,
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INTRODUCTION:

Department of Zoology was established in 1990 for the teaching of graduate and post graduate courses affiliated with Punjab University, Lahore, then took a mature turn after the up-gradation of Govt. College Faisalabad as Govt. College University, Faisalabad in 2002. Later on launching of MPhil, PhD and Honors programs added to its status and it has come forth as one of the academically sound Department of the country. The high profile motivated faculty loaded with initiative and drive is key strength of the Department. The fully equipped laboratories, well-furnished class rooms and update spacious library provide the best possible facilities to the students in their academic pursuits.

All the faculty members under the dynamic leadership of Dr. Farhat Jabeen are striving hard and exercising their potentialities to the maximum extent focusing the activity based learning. University industry linkage program for the joint research ventures have been initiated. For this purpose the Department has established a linkage through signing MoU with Newcastle University UK, WASA and Punjab Fisheries Department with an objective of sharing research facilities for educational and career development of the students coherent with professional requirement. The Department believes in its uplifting at world recognized level through imparting outstanding teaching and research by awarding degree in academic programs of BS, MSc, MS /MPhil and PhD in Zoology.

Recently department has recruited foreign qualified PhD faculty members to broaden the teaching and research horizon to face the modern challenges in the field of Science and Technology. Entomology, Fish Nutrition and Wet labs have been established to extend its infrastructure. Department has research project under INSPIRE Program (British council-Higher Education Commission funded project) and its two extension programs SPEKE and TNE on its credit. Moreover various other projects funded by Pakistan Science Foundation (PSF) and Higher Education Commission are being running in the Department.

Courses

PART-I

Paper #	Title	Theory*	Practical*	Total
I	Biochemistry	70	30	100
II	Cell and Molecular Biology	70	30	100
III	Genetics and Biostatistics (Weightage 3:1)	70	30	100
IV	Physiology	70	30	100
V	Developmental Biology	70	30	100
VI	Animal Diversity and Wildlife (Weightage 4:1)	70	30	100
	Total:			600

*Theory and practical are independent parts of each course. Student must pass in both parts independently to qualify in the course. Failure in any part will require re-appearance in both to qualify the course.

Dr. Farhat Jabeen
Chairperson
Department of Zoology
Government College University, Faisalabad

DETAILED COURSES OF READING

M.Sc. PART-I (ALL COMPULSORY SUBJECTS)

I. **BIOCHEMISTRY**

Theory

Amino acids: Amino acids, their structure and Classification; Properties of amino acids ; Peptides; Three dimensional structure of proteins, Secondary and supra secondary structures of proteins; Alpha-Keratin, Collagen and silk; Tertiary and Quaternary structure of proteins, Globular proteins, Myoglobin, Haemoglobin and their oxygen binding properties;. Protein Denaturation; Separation technique; Ion exchange chromatography.

Enzymes: Characteristics of enzymes; enzymes action; Cofactors; Enzyme kinetics, Effect of substrate concentration, pH and temperature enzyme activity; Enzyme Inhibition. Enzymes regulation Allosteric regulation; Reversible covalent modification of Enzymes.

Carbohydrates: Classification, types, characteristics and structure of Monosaccharides; Oligosaccharides and Polysaccharides; Storage and Structural carbohydrates, glycoprotein.

Lipids: Fatty acids, their types and major characteristics; Storage Lipids, Acylglycerols; Waxes; Structural Lipids in membranes, phosphoglycolipids, Sphingolipids,; Glycolipids and their role; Isoprenoids, Terpenoids and Sterols; Major functions of Lipids; Lipoproteins, their types and major functions; Prostaglandin.

Nucleic Acids: Structure of DNA and RNA.(The functional aspects will be dealt in Cell biology course)

Bioenergetics: Concept of Free Energy; Standard Free Energy change: Energy rich compounds.

Metabolism: description of Glycolysis Regulation and Bioenergetics of Glycolysis. Anabolic role of Glycolysis; Fate of Pyruvate; Gluconeogenesis, its Regulation and significance in tissues; Utilization of other carbohydrates Glycogen synthesis and degradation; Regulation of Glycogen metabolism;; Pentose phosphate pathway and its major role in the animal tissues.

Citric acid (TCA) cycle: Conversion of Pyruvate to Acetyl CoA, Pyruvate dehydrogenase, a multi-enzyme complex; description of citric acid cycle; Bioenergetics of 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 chain.

Lipid metabolism: Fate of dietary fat; Activation of Fatty acids and their transportation to mitochondria; Beta-Oxidation; Alpha oxidation; Bioenergetics of Beta-oxidation; Oxidation of unsaturated and Odd chain fatty acids; Omega oxidation pathway; Biosynthesis of Saturated Fatty acid; Biosynthesis of unsaturated Fatty acids. Ketone bodies their biosynthesis, utilization and role in the tissues; Cholesterol metabolism: Cholesterol biosynthesis and its Regulation.

Nitrogen Metabolism: Metabolic fate of amino acids; Catabolism of Amino acids; Deamination and Transamination; Nitrogen Excretion and Urea cycle; Regulation of Urea cycle; Decarboxylation of Amino acids to Biological Amines.; Purine and Pyrimidine synthesis showing the sources of various atoms in both molecules.

Recommended text book

1. David L. Nelson, and Michael M. Cox, 2000. Lehninger Principles of Biochemistry, 3rd Ed., Macmillan Worth Publishers, New York.

2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W., 2000. Voet, D., Voet, J.G., and Pratt, C.W., 1999. Fundamentals of Biochemistry, John Wiley and Sons, Inc., New York.
3. Zubay, G., 1995. Biochemistry, 4th Ed., Wm. C. Brown Publishers, Inc., Oxford, England.
4. Stryer, L., 1995. Biochemistry, 6th Ed., W.H. Freeman and Company, New York.

Practicals

Experiment 1:

Preparation of standard curve for glucose by *ortho*-Toluidine method.

Experiment 2:

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

Experiment 1:

Tests for detection of carbohydrates in alkaline medium.

Experiment 2:

Tests for detection of carbohydrates in acidic medium.

Experiment 3:

Tests for detection of Disaccharides.

Tests to demonstrate relative instability of glycosidic linkage in carbohydrates.

Experiment 4:

Detection of Non-Reducing sugars in the presence of Reducing sugars.

Experiment 5:

Demonstration of Acid Hydrolysis of Polysaccharide.

Experiment 6:

Determination of pKa values of an amino acid by preparation of titration curves.

Experiment 7:

Preparation of standard curve of proteins by Biuret method.

Experiment 8:

Estimation of blood serum proteins or any unknown concentration of protein using Biuret technique.

Experiment 9:

Biochemical tests for detection of different amino acids.

Experiment 10:

Separation and identification of various amino acids by Paper/Thin layer chromatography.

Experiment 11:

Demonstration of differential solubility of lipids in various solvents.

Experiment 12:

Various Qualitative Tests for detection of Lipids.

Experiment 13:

Determination of Acid value of Fats.

Experiment 14:

Preparation of standard curve and Estimation of DNA by colorimetric analysis using Diphenylamine method.

Experiment 15:

Preparation of standard curve and Estimation of total RNA by colorimetric analysis using Bial's Orcinol method.

Experiment 16:

Quantitative analysis of Amylase activity from blood serum or liver.

Experiment 17:

Effect of temperature on the enzymatic rate of reaction.

Books Recommended

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

II. CELL AND MOLECULAR BIOLOGY

Theory

Chromatin, heterochromatin, euchromatin, chromosome structure with reference to coiling and nucleosome during different phases of cell cycle,

DNA physical and chemical structure, characteristics of DNA,

DNA replication (mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes with special reference to DNA polymerases, concept of Replicons etc.), DNA repair,

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 (with reference to the specific role of Ribosomes, various factors, and posttranslational processing),

Regulation of Gene Expression (enzyme induction, enzyme repression, role of promoter and operator to be elucidated taking examples of Lac operon and Trip Operon, Gene Regulation in Eukaryotes with reference to elaborate promoter and diverse transcription factors involved, concept of examples of Transcriptional Regulation and Translational Regulation).

Nuclear Envelope, Nucleolus

Recombinant DNA technology

General Principles, molecular tools involved (vectors, enzymes, expression system) DNA sequencing, chromosome walking, PCR techniques.

Role of Genetic Engineering in Economic Development in the areas of

Medicine and Human Health (Therapeutic Drug, Vaccines, Monoclonal antibodies, Gene therapy, Animal Cloning, Human Genome Project, Stem Cells, Transgenics Ethical issues),

Agriculture (Livestock Health, increase in agricultural produce),

Industry (organic solvents, petroleum industry, ore leaching etc.).

Cytoplasmic Organelle: Membrane system (structural and functional commonalities). Ultrastructure, chemical composition and functions of Endoplasmic Reticulum with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus (with reference to its role in synthesis of glycoprotein), Mitochondria (with reference to its role in cellular respiration, and its significance as semi-autonomous organelle), Lysosome (with reference to its diverse roles due to hydrolytic activity of enzymes), peroxisome (with reference to metabolism of hydrogen peroxide), glyoxysome (with reference to glyoxylic acid cycle).

Plasma membrane and its functions: Chemical composition and structure of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis.

Cytoskeleton: Microfilaments, Microtubules, Intermediate filaments.

Practicals

Histochemistry of tissues, preparation and study of tissue structure; Extraction of DNA (bacterial); Minipreparation of plasmid DNA; Restriction digestion of plasmid DNA; Isolation and characterization of proteins on polyacrylamide gel electrophoresis; Western blotting; Cloning and transformation; PCR amplification of DNA.

Books Recommended:

Text Book

1. DeRobertis and DeRobertis Cell And Molecular Biology, 8 Ed., Publisher: Lippincott Williams and Williams (2008)

Books Recommended:

2. Albert, B., Bray, D., Lewis, J., Raff, M. et al. 2002. Molecular Biology of the cell 4th Ed. Garland publishing Inc. New York.
3. Karp G. 2009. Cell and Molecular Biology Wiley; 6 Ed., ISBN-10: 0470483377
4. Harvey Lodish et al. 2000. Molecular Cell Biology 4th Ed. W.M. Freeman, New York.
5. Robert F. Weaver. 2005. Molecular Biology 3rd Ed. The McGraw Hill companies Inc. International Ed.
6. Bernard R. Glick and Jack J. Pasternate. 1994. Molecular Biotechnology: Principles and applications of Recombinant DNA. ASM press, Washington, D.C., USA.

III. GENETICS AND BIOSTATISTICS

Theory

Genetics

History of Genetics,

Classical Genetics –Multiple Alleles, Genetics of Blood Groups, Chromosomal Basis of Inheritance, Interaction of Genes, Chromosomal changes (Euploidy, Aneuploidy, Structural changes), Sex-Determination and Sex-Linkage, Linkage, Recombination and Chromosome mapping in Eukaryotes.

Molecular Genetics – Mutation, DNA repair and Recombination, Gene Concept (classical and modern), Genetics of Viruses, Bacteria, Transposons, Molecular Genetic Analysis, The

Techniques of Molecular Genetics (elements of genetic engineering), Regulation of Gene Expression in Prokaryotes, Gene Regulation in Eukaryotes The genetic control of the Vertebrate Immune System, Complex Inheritance Patterns.

Population Genetics – Hardy-Wimberg Equilibrium, Systematic and Dispersive Pressures, Inbreeding and Heterosis.

Biostatistics

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 of tables and charts. Measures of central tendency (computation of from grouped and ungrouped data). Measures of dispersion, computation of variance, standard deviation, standard error and their coefficients. Probability rules and distribution. Binomial, Poisson and Normal distributions. Hypothesis testing, Z- test, student's 't' test, Chi square test, Analysis of variance and DMRT. Correlation and regression. Experimental designing, Planning of an experiment replication and randomization.

Practicals

Problems related to concepts of Classical and Population genetics, Pedigree Analysis Dtermination of inheritancve pattern of different human characters (Widows Peak, ear loop, etc) Isolation of DNA from Bacteria, Isolation of Plasmids, PCR.

Books Recommended:

1. PRINCIPALS OF GENETICS Gardner E.J., Simmons M.J. and Snistad A.P. (Latest available Addition)
2. Text Book for Biostatistics: ELEMENTRY STATISTICS A STEP BY STEP APPROACH, By Bluman.A. G Latest available Addition
3. Reference Books. Concepts of Genetics By Klug, W.S and Cummings M.R.

IV. PHYSIOLOGY

Theory

Central themes in Physiology: Structure-Function Relationship, Adaptations, Homeostasis, Conformity and Regulation.

Physiological basis of Neuronal Function: *Mechanisms in Resting Membrane Potentials:* Electrogenic ion pump, Donnan equilibrium, diffusional potentials, ion channels, *Ionic mechanisms in action potentials:* Roles of ion channels, Properties of action potential. *Propagation of Action Potential; Synaptic transmission;* Structure and function of electrical synapse structure and function of chemical synapse; Neurotransmitters; Synaptic receptors; Excitatory postsynaptic potentials; Inhibitory postsynaptic potentials; Presynaptic inhibitions; Integration at synapses: Facilitation, Posttetanic Potentiation.

Receptors Physiology: Transduction; Sensory coding; Mechanoreception: Hair cell mechanism particularly in acoustico-lateralis system of vertebrates; Cellular and molecular mechanisms in taste and olfactory reception; Photoreception: Ultrastructure of photoreceptors, Photochemistry, Phototransduction and physiological basis of color vision.

Chemical Messenger and Regulators/Endocrine Physiology: Types and functions of secretions. An overview of hormones, their chemistry and physiological roles of Hypthalamus,

Pituitary, Thyroid, Parathyroid and associated structures, Endocrine pancreas, Gastroenteropancreatic system, Adrenal medulla, Adrenal cortex, Ovary, Testis and placenta. A generalized model account of hormone synthesis, storage and secretion (a peptide hormone model and steroid hormones); Hormonal interactions in metabolic and developmental function; Water and electrolyte balance; reproduction; glycemia and calcium homeostasis. Mechanisms of action in hormones involving membrane receptors and nuclear modulated gene expression

Movements and Muscles: Structural basis of muscle contraction: molecular structures of contractile components and their interaction, sarcoplasmic reticulum, calcium and membrane mechanisms in regulation of contraction.

Cardiovascular Mechanisms: Electrical activity of heart: Automaticity, Rhythmicity, Electrocardiography, Hemodynamics, Blood flow, pressures and resistance and their interrelationships. Control of cardiac activity (cardiac output) and peripheral circulation.

Exchange of Gases: Exchange of O₂ and CO₂ between respiratory surface (the lungs) and body cells. Transport of O₂ and CO₂ in blood. Nervous and chemical regulation of lungs respiration;

Excretion and Osmoregulation: Osmoregulation in aquatic and terrestrial environment. Vertebrate nephron as osmoregulatory organ: Physiological anatomy, Glomerular filtration, Tubular absorption and secretion; Nitrogenous waste products; Patterns of nitrogenous excretion and their phylogenetic development.

Nutrition: Regulation of digestive secretions; Physiological anatomy of digestive tract (mammalian model), Absorption of water, ions and nutrients; Potential and Movements in Gastrointestinal tract; Control of Motility.

Books Recommended:

1. Guyton, A.C. and Hall, J.E., 2006. Textbook of Medical Physiology, 11th Ed.. W.B. Saunders Company, Philadelphia.
2. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
3. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company, New York

Practicals

Muscle and Neuromuscular Activity: 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.

Excitability, Sensation and Behaviour: 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.

Cardiovascular Activity: Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure. Hemolytic responses of erythrocytes in hyper and hypotonic solutions.

Respiration and Exercise: 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.

Endocrine and Reproductive Mechanisms: Effect of insulin on glycemia, study of stages in estrous cycle.

Books Recommended:

1. Tharp, G. and Woodman, D., 2011. Experiments in Physiology, 10th Ed.. Prentice Hall, London.

V. DEVELOPMENTAL BIOLOGY

Theory

Introduction: Principal features of development, origin of sexual reproduction, developmental patterns; Spermatogenesis; Oogenesis; Fertilization: Recognition of sperm and egg, fusion of gametes, activation of egg metabolism, rearrangement of egg cytoplasm; Cleavage: Patterns of embryonic cleavage, mechanism of cleavage; Gastrulation: Fate maps, gastrulation in sea urchin, amphibians, birds and mammals. Early Vertebrate Development: Neurulation, ectoderm, mesoderm and endoderm.

Cellular Basis of Morphogenesis: Differential cell affinity, cell adhesion molecules; Mechanism of Cellular Differentiation: RNA processing, translational regulation of developmental process, cell-fate by progressive determinants, autonomous cell specification by cytoplasmic determinants, establishment of body axes and mechanism of teratogenesis; Secondary Induction; Organogenesis: A brief account; Origin and Migration of Germ Cells in Vertebrates; Factors controlling Growth and Oncogenesis. Hormones as Mediators of Development; Regeneration in Vertebrates.

Practicals

Study of structure of gametes in some representative cases, i.e., frog, fish, fowl and mammal. Study of cleavage and subsequent development from prepared slides and/or whole mounts in various animals i.e., frog, chick etc. Study of fertilization, early development of frog through induced spawning under laboratory conditions. Preparation and study of serial sections of frog or chick embryos. Application of microsurgical techniques on chick embryos *in vitro*. Preparation and staining of histological slides.

Books Recommended:

1. Scott F. Gilbert. 2000. Developmental Biology, Sinauer Associates Inc., Publishers, Massachusetts.
2. Bruce M. Carlson. 2000. Human Embryology and Developmental Biology, Mosby, London.
3. Oppenheimer. 1989. Introduction to Embryonic Development, S.S. Allen and Bacon.
4. Balinsky, B.I. 1985. An Introduction to Embryology, W.B. Saunders, New York.

VI. ANIMAL DIVERSITY AND WILDLIFE

Animal diversity

Animal diversity in different ecosystems, desert animals, polar animals, forest dwelling animals, grassland and savannah animals, high altitudes animals, freshwater animals, shore animals, deep sea animals, animals that live around hydrothermal vents.

Structural diversity and adaptations to different modes of existence in the different phyla of the animal kingdom.

The hierarchical organization of animal diversity, Complexity and body size, Animal body plan, Animal Symmetry,

Major sub divisions of the animal kingdom, Phylogenetic relationship of all major phyla. Modern classification of animals including minor phyla.

Wildlife

Introduction to wildlife, Philosophy and significance of wildlife.

Animal distribution in Pakistan and their affinities.

Important wild animals, distribution, status, conservation and management (population estimates and diversity indices).

IUCN categories of wildlife status.

In-situ, ex-situ conservation,

Wildlife benefits, Zoonotic diseases,

Provincial wildlife rules in Pakistan, Zoo rules, National and International organizations involved in conservation and management of wildlife,

National Park, Wildlife Sanctuary, and Game Reserves in Pakistan,

IUCN protected areas, Eco-regions, Ramsar Convention, Ramsar sites of Pakistan, Major threats to wetlands.

Threatened species of Pakistan.

Practicals:

Study of museum specimens with their notes on adaptive characteristics, ecology and habitats.

Field work and study of species richness, species evenness, relative abundance, Simpson Index, Shannon Weiner Index.

Demonstration of distribution of animal species of Pakistan, (Blank map will be provided),

Individual presentation of threatened wild animal of Pakistan assigned to students.

Books Recommended:

1. Bailey, J.A., 1986. Principles of Wildlife Management, John Wiley.
2. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing & Co. London, UK.
3. Grimmett, R. Inskipp, C. and Inskipp, T. 2001, Birds of the Indian Sub-Continent. Helm.
4. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
5. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition). McGraw Hill, New York.
6. Hickman, Roberts, and Larsen, 2004. Integrated principles of Zoology (12th Edition). McGraw Hill, New York.

7. Jordan, E. L. and Verma, P. S. 2011. Invertebrate Zoology, S. Chand and Company.
8. M. S. Khan. 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Florida USA.
9. M. M. Shafique, 2005. Wildlife Acts and Rules of Pakistan. PFI, Peshawar.
10. Miller and Harley, 2007. Zoology (7th Edition). McGraw Hill, New York.
11. Mirza . Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
12. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley & Sons, Inc.
13. Odum, E.P., 1994. Fundamentals of Ecology, W.B. Saunders.
14. Pough, F. H., Janis, C. M. and Heiser, J. B. 2006. Vertebrate Life, 6th Ed. Pearson Prentice Hall.
15. Prasad, S. N. and Kashyap, V. 2011. A textbook of Vertebrate Zoology, New Age International Publishers.
16. Punjab Wildlife Act 1974. Government of the Punjab.
17. Roberts, T. J. 1991. Birds of Pakistan. Vol. I Oxford
18. Roberts, T. J. 1992. Birds of Pakistan. Vol. II. Oxford
19. Roberts, T. J. 1997. Mammals of Pakistan. Vol. II. Oxford
20. Roberts, T. J. 2005. Field Guide to the large and Medium-sized Mammals of Pakistan. Oxford
21. Roberts, T. J. 2005. Field Guide to the small Mammals of Pakistan. Oxford
22. Robinson, W.L. and Bolen, E.G., 1984. Wildlife Ecology and Management. McMillan, Cambridge.
23. S. S. Ali, 1999. Zoogeography, Paleontology and Wildlife Management, Naseem Book Depot, Hyderabad.
24. Singh, S. K. 2005. Text Book of Wildlife Management. IBDC
25. Smith, R. L. 1980. Ecology and field biology, Harper and Row.