MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY (MUST), MIRPUR
DEPARTMENT OF ZOOLOGY
Proposed Agenda for the 4th Meeting of Departmental Council scheduled to be held on 26-04-2018

Agenda for the 4th Meeting of Departmental Council

Annex	Agenda Item	Page No.	Recommendations
I.	Approval of the minutes of the 3rd Meeting of the BoS held on 16-03-2017.	2	
II.	Approval of the scheme of studies/syllabi in B. Sc. (Pass course) w.e.f. 2018 and onward.	5	
III.	Approval of the scheme of studies/syllabi in BS w.e.f. 2018 and onward.	14	
IV.	Approval of the scheme of studies/syllabi in M. Sc. w.e.f. 2018 and onward.	83	
V.	Approval of the scheme of studies/syllabi in M. Phil w.e.f. 2018 and onward.	140	
VI.	Approval of the scheme of studies/syllabi in Ph. D. w.e.f. 2018 and onward.	186	
VII.	Titles of M. Phil. Theses for approval (Session 2014-16).	195	
VIII.	Approval of List of External Examiners for M. Phil/Ph. D Examinations (Local +foreign).	196	
	Any other Item		

Chairman

ANNEXURE-I

MINUTES OF THE 3rd MEETING OF BOARD OF STUDIES IN ZOOLOGY

The 3rd meeting of the Board of Studies (BoS) of the Department of Zoology was held in the Chairman Office, Department of Zoology, Mirpur University of Science & Technology Mirpur on 16-03-2017. Prof. Dr. Mushtaq Ahmed, Chairman/Convener of the BoS chaired the meeting. The following Members participated in the meeting:

1. Prof. Dr. Mushtaq Ahmed, Department of Zoology, MUST Chairman/Convener
2. Dr. Afsar Mian HEC Professor Member
3. Dr. Maqsood Anwar Dean Faculty of Range Management & Wildlife, AAUR. Member
4. Dr. Muhammad Nasim Khan, Department of Biotechnology, UAJK Member
5. Mr. Khawaja Zafar, PGC for Boys, Mirpur Member
6. Mr. Rizwan Ullah, Department of Zoology, MUST Member
7. The Registrar Ex-officio Member
8. The Controller of Examinations Ex-officio Member
9. The Director QEC Ex-officio Member

The meeting started at 10 a.m. at the Department of Zoology, Mirpur University of Science and Technology, Mirpur. Prof. Dr. Mushtaq Ahmed, the Convener of the BoS in Zoology welcomed the participants on behalf of the Vice Chancellor, Mirpur University of Science & Technology Mirpur. The Convener presented the items on the Agenda. The participants discussed fervently the various aspects of the items on the agenda and approval was accorded as per detail given below:

1. **The Minutes of 2nd Meeting of Board of Studies, Held on 23-12-2015**

   Convener of the meeting presented the minutes of 2nd meeting of the board of studies held on 23-12-2015. The members read the minutes and approved unanimously.

2. **Scheme of Studies for M. Phil/Ph. D Zoology w.e.f. 2017.**

   Schemes of studies for M. Phil and Ph. D in Zoology were discussed in detail and approved unanimously. Some recommendations are listed below.

   Members of the BoS observed that there is no provision of practical in Campus Management System (CMS) at MUST. Practical are the important part of science studies, M. Phil/PhD are research based degrees and the courses taught in such programs and their practical aspects are performed in the laboratories or field, provision of separate credit hour(s) and marks are not shown in CMS results. Therefore the appearance of the particular could not be made on the transcripts. It is recommended that practical should separately be mentioned on the transcripts and in order to do so, relevant changes in CMS are suggested. Such reflection will help students to compete with the graduates of other universities of Pakistan, where such reflection is made on M. Phil/Ph. D transcript.

3. **Titles of M. Phil. Theses for approval (Session 2013-15)**

   The theses titles of M. Phil. Scholars for Session 2013-15 were approved unanimously. To comprehend the theses titles, BoS members recommended that these titles should be discussed, analyzed and approved by a departmental committee prior to get their approval from the Advance Studies and Research Board and other statutory bodies. It is also recommended that thesis and seminar code numbers should be identical in all disciplines in the university, because these are offered in all departments with same workload. The suggested code numbers are *-790 and *-791 for M. Phil/Ph. D thesis and seminar respectively.

4. **Panel of Examiners for M. Phil/Ph. D Examinations for Approval (Local + Foreigners).**

List of examiners for M. Phil and Ph. D Degree programs were approved unanimously.

At the end of the formal meeting, Prof. Dr. Mushtaq Ahmed thanked the participants for the approval of the proposed Agenda of the 3rd meeting of BoS. The Convener appreciated the valuable suggestions, guidance and cooperation of the members of the BoS.

Chairman/ Convener

ANNEXURE-II

B.Sc. (PASS COURSE)

(Scheme of Study)

Paper No.	Title	Marks
Part I (3rd Year)		
Paper I	Biodiversity of Invertebrates	40
Paper II	Principle of Cell Biology	40
Practical Paper I &II		20
	Sub-total Part I (3rd Year)	**100**
Part II (4th Year)		
Paper III	Biodiversity of Chordates	40
Paper IV	Form and Function (Comparative Perspective)	40
Practical Paper III & IV		20
	Sub-total Part II (4th Year)	**100**
Grand Total		**200**

COURSE CONTENTS FOR B.Sc. ZOOLOGY

PAPER: I BIODIVERSITY OF INVERTEBRATE

Invertebrates Diversity Classification, Phylogeny and Organization

1. Place of Zoology in Science:

A One-World View: Genetic Unity. The Fundamental Unit of Life, Evolutionary Oneness and the Diversity of Life, Environment and World Resources; What is Zoology? The Classification of Animals; The Scientific Method.

2. Introduction:

Classification of Organisms; Evolutionary Relationships and Tree Diagrams; Patterns of Organization.

3. Animal-Like Protists: The Protozoa

Evolutionary Perspective; Life within a single Plasma Membrane; Symbiotic Life-styles. Protozoan Taxonomy; (up to phyla, subphyla and superclasses, wherever applicable). Pseudopodia and Amoeboid Locomotion; Cilia and Other Pellicular

Structures; Nutrition; genetic Control and reproduction; Symbiotic Ciliates; Further Phylogenetic Considerations.

4. Multicellular and Tissue Levels of Organization.

Evolutionary Perspective: Origins of Multicellularity; Animal Origins. Phylum Porifera; Cell types, Body Wall and Skeletons; Water currents and body Forms; Maintenance Functions, Reproduction. Phylum Cnidaria (Coelenterata). The Body Wall and Nematocysts: Alternation of Generations; Maintenance Functions; Reproduction and Classification up to class. Phylum Ctenophora; Further Phylogenetic Considerations.

5. The Triploblastic: Acoelomate Body Plan

Evolutionary Perspective; Phylum Platyhelminthes; Classification up to class; the Free-Living Flatworms and the Tapeworms, Phylum Nemertea; Phylum Gastrotricha; Further Phylogenetic Considerations.

6. The Pseudocoelomate Body Plan: Aschelminthes

Evolutionary Perspective; General Characteristics; Classification up to Phyla with External Features; Feeding and the Digestive System; Other Organ Systems; Reproduction and Development of phylum Rotifera and phylum Nematoda; Phylum Kinorhyncha some important Nematode Parasites of Humans; Further Phylogenetic Considerations.

7. Molluscan Success

Evolutionary Perspective; Relationship to other Animals; Origin of the Coelom; Molluscan Characteristics, Classification up to class. The Characteristics of shell and Associated Structures, Feeding, Digestion, Gas Exchange, Locomotion, Reproduction and Development, other Maintenance Functions and Diversity in Gastropods, Bivalves and Cephalopods: Further Phylogenetic considerations.

8. Annelida: The Metameric Body Form

Evolutionary Perspective; relationship to other Animals, Metamerism and Tagmatization, Classification up to class. External Structure and Locomotion, Feeding and the Digestive System, Gas Exchange and Circulation, Nervous and Sensory Functions, Excretion, Regeneration, Reproduction and Development in Polychaeta, Oligochaeta and Hirudinea, Further Phylogenetic Consideration.

9. The Arthropods: Blueprint for Success

Evolutionary Perspective: Classification and Relationships to other Animals; Metamerism and Tagmatization; The Exoskeleton; Metamorphosis, Classification up to class; Further Phylogenetic Considerations.

10. The Hexapods and Myriapods: Terrestrial Triumphs

Evolutionary Perspective: Classification up to class. External Structure and Locomotion, Nutrition and the Digestive System, Gas Exchange, Circulation and Temperature Regulation, Nervous and Sensory Function, Excretion, Chemical Regulation, Reproduction and Development in Hexapoda, Insects Behaviour, Insects and Humans; Further Phylogenetic Considerations.

11. The Echinoderms

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

PRACTICAL PAPER I: (Biodiversity-I) (Invertebrate)

1. Study of Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma, and Paramecium as representative of animal like protists.
2. Study of sponges and their various body forms.
3. Study of principal representative classes of phylum Coelenterata.
4. Study of principal representative classes of phylum Platyhelminthes.
5. Study of representative of phylum Rotifera, Phylum Nematoda.
6. Study of principal representative classes of phylum Mollusca.
7. Study of principal representative classes of phylum Annelida.
8. Study of principal representative classes of groups of phylum Arthropoda and Echinoderms.
9. Dissection and study of all major systems
    a) Earthworm or Leech
    b) Cockroach or Locust
    c) Freshwater muscle
10. Brief note on medical/economic importance of; Plasmodium, Entamoeba histolytica, Leishmania, Liverfluke, Tapeworm, Earthworm, Silkworm, Citrus Butterfly.
11. Preparation of permanent stained slides of the following; Paramecium, Obelia, Daphia, Cestode, Parapodia of Nereis.

PAPER II: PRINCIPLES OF CELL BIOLOGY

1. The chemical Basis of Animal Life

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

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

Structure and Functions of Cell Membranes; Various Movements across Membranes; Cytoplasm, Organelles and Cellular Components; Functional account of

Ribosomes, Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Mitochondria, Cytoskeleton, Cilia and Flagella, Centrioles, Microtubules and Vacuoles based on their structural aspects. The Nucleus: Nuclear Envelope, Chromosomes and Nucleolus. Tissues; Diversity in Epithelial Tissue, Connective Tissue, A Muscle Tissue and Nervous Tissue to perform various functions. Structural integrations for functions in Organs and Organ Systems.

3. Energy and Enzymes: Life's Driving and Controlling Forces

Energy and the Laws of Energy Transformation; Activation Energy; Enzymes; Structure, Function and Factors Affecting their Activity; Cofactors and Coenzymes; ATP: How Cells Convert Energy-An Overview.

4. How Animals Harvest Energy Stored in Nutrients

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

5. Cell Division

Mitosis, Cytokinesis and the Cell Cycle: an overview; Control of the cell cycle Meiosis: The Basis of Sexual Reproduction; Gamete Formation.

6. Inheritance Patterns

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

7. Chromosomes and Gene Linkage

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

8. Molecular Genetics: Ultimate Cellular Control

DNA: the Genetic Material; DNA Replication in Eukaryotes, Genes in Action; Control of Gene Expression in Eukaryotes; Mutation; Applications of Genetic Technologies, Recombinant DNA.

9. Ecology 1: Individuals and Populations

Animals and their Abiotic environment; Population; Interspecific Interactions.

10. Ecology II Communities and Ecosystems

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

11. Animal Behaviour

Four approaches to Animal Behaviour, Proximate and Ultimate Causes; Anthropomorphism; Development of Behaviour, Learning, Control of Behaviour, Communication; Behavioural Ecology; Social Behaviour.

PRACTICAL

1. Tests for different carbohydrates, proteins and lipids.

2. Study of the prepared slides of squamous, cubidal, columnar epithelial tissues, adipose, connective, cartilage bone, blood, nervous, skeletal muscle, smooth muscle and cardiac muscle tissues.
3. Plasmolysis and deplasmolysis in blood
4. Protein digestion by pepsin.
5. Study of mitosis in onion root tip.
6. Study of meiosis in grass hopper testis.
7. Problem based study of Mendelian ratio in animals.
8. Multiple alleles study in blood groups.
9. Survey study of a genetic factor in population and its frequency.
10. Study of Karyotypes of Drosophila and Mosquito.
11. Study of cytochemical demonstration of DNA and RNA in protozoa and avian blood cell.
12. Study of stages in the development of an Echinoderm.
13. Study of early stages in the development of a frog, chick and a mammal.
14. Demonstration of social behaviour (Documentary film be shown).
15. Ecological note on animals of a few model habitats.
16. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).
17. Study of Human Blood Groups
18. Study of Human Blood Cell

Paper III: BIODIVERSITY OF CHORDATES

1. Hemichordata and Invertebrate Chordates

Evolutionary Perspective: Phylogenetic Relationship; Classification up to Subphylum or class where applicable; Further Phylogenetic Considerations.

2. The Fishes: Vertebrate Success in Water.

Evolutionary Perspective: Phylogenetic Relationships; Survey of Super-class Agnatha and Gnathosiomala; Evolutionary Pressures: Adaptations in Locomotion, Nutrition and the Digestive System, Circulation, Gas Exchange, Nervous and Sensory Functions, Excretion and Osmoregulation, Reproduction and Development; Further Phylogenetic Consideration.

3. Amphibians: The First Terrestrial Vertebrates

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

and Osmoregulation, Reproduction and Development; Further Phylogenetic Considerations.

4. Reptiles: The First Amniotes

Evolutionary Perspective: Cladistic Interpretation of the Amniotic Lineage Survey of Order Testudines or Chelonia, Rhynchocephalia, Squamata and Crocodilia; Evolutionary Pressures, Adaptation in External Structure and Locomotion, Nutrition and the Digestive System, Cirulation, Gas Exchange and Temperature regulation, Nervous and Sensory Function, Excretion and Osmoregulation, Reproduction and Development; Phylogenetic Considerations.

5. Bird: Feathers, Flight and Endothermy

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

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

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

7. Evolution: A Historical Perspective

Pre-Darwinian theories of Change; Lamarck; An Early Proponent of Evolution; Early Development of Darwin's Ideas of Evolution and Evidences; the Theory of Evolution by Natural Selection, Evolutionary Thought after Darwin; Biogeography.

8. Evolution and Gene Frequencies

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

Practical paper III (Biodiversity-II (Chordates)

1. Study of a representative of hemichordate and invertebrate chordate.
2. Study of representative groups of class fishes.
3. Study of representative groups of class Amphibia.
4. Study of representative groups of class Reptelia.
5. Study of representative groups of class Aves.
6. Study of representative groups of class Mammalia.
7. Field trips to study animal diversity in an ecosystem.

8. Study of scales in fish and reptiles; amphibian and mammalian skin; feathers in aves.
9. Skeleton: study of Labeo; frog, varanus, fowl and rabbit; adaptation of skeleton t their function should also be studied.
10. Dissection of
    - Scoliodon or any easily available fish
    - Frog
    - Uromastix
    - Pigeon
    - Rabbit (for studying the following systems)
        - Nervous System
        - Digestive System
        - Respiratory System
        - Circulatory System
        - Endocrine System
        - Urinogenital System

PAPER IV: ANIMAL FORM AND FUNCTION: (A COMPARATIVE PERSPECTIVE)

1. Protection, Support and Movement

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

2. Communication I: Nerves

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

3. Communication II: Senses

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

4. Communication III: The Endocrine System and Chemical Messengers

Chemical Messengers : Hormones Chemistry and Their Feedback Systems; Mechanisms of Hormone Action; Some Hormones of Porifera, Cnidarians, Platyhelminthes, Nemerteans, Nematodes, Molluscs, Annelids, Arthropods and Echinoderms Invertebrates; An overview of the Vertebrate Endocrine system ; Endocrine systems of Vertebrates other than Birds or Mammals; Endocrine systems of Birds and Mammals.

5. Circulation, Immunity and Gas Exchange

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

6. Nutrition and Digestion

Evolution of Nutrition: The Metabolic Fates of Nutrients in Heterotrophs, Digestion; Animal Strategies for Getting and Using Food Diversity in Digestive Structures of Invertebrates and Vertebrate; The Mammalian Digestive System; Gastrointestinal Motility and its Control, Oral Cavity, Pharynx and Esophagus, Stomach, Small Intestine: Main Site of Digestion, Large Intestine; Role of the pancreas in Digestion and Role of the Liver and Gallbladder in Digestion.

7. Temperature and Body Fluid Regulation.

Homeostasis and Temperature Regulation: The impact of temperature on Animal Life; Heat gains and losses. Some Solutions to Temperature Fluctuation; temperature Regulation in Invertebrates, Fishes, Amphibians, Reptiles, Birds and Mammals; heat production in birds and Mammals, control of water and solutes (Osmoregulation and Excretion), Invertebrate and Vertebrate Excretory Systems; how Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions.

8. Reproduction and Development

Asexual Reproduction in Invertebrates; Advantages and Disadvantages of Asexual Reproduction; Sexual Reproduction in Invertebrates, Advantages and Disadvantages of Sexual Reproduction, Sexual Reproduction in Vertebrates; Reproductive Strategies: Examples of Reproduction among Various Vertebrate Classes; The Human Male Reproductive system; Spermatogenesis, Transport and Hormonal control, Reproductive Function; The Human Female Reproductive system: Folliculogenesis, transport and Hormonal control, Reproductive function, Hormonal regulation in gestation; Prenatal development and birth events of prenatal development: The Placenta ; Birth: Milk Production and Lactation.

9. Descriptive Embryology

Fertilization; Embryonic Development: Cleavage and Egg types; The Primary Germ Layers and their derivatives; Echinoderm Embryology; Vertebrate Embryology:

the Chordate Body Plane, Amphibian Embryology, Development in Terrestrial Environments, Avian Embryology, the fate of mesoderm.

PRACTICAL PAPER IV

ANIMAL FORM AND FUNCTION: (A COMPARATIVE PERSPECTIVE)

1. Study of the following prepared slides
    - ✓ Mammalian Skin
    - ✓ Arteries and Vein
    - ✓ Small and large intestine
    - ✓ Stomach
    - ✓ Pancreas
    - ✓ Liver
    - ✓ Testes
    - ✓ Ovaries
2. Study of cardiac cycle in Frog
3. Study of contractility in skeletal muscle of Frog
4. Study of effect of different hormones (adrenaline and acetylcholine) on cardiac activity of frog.
5. Study of Embryonic development in Chick.

RECOMMENDED BOOKS FOR LECTURES

1. Miller, A.S. and Harley, J.B.; 1999 & 2002. Zoology, 4th & 5th Edition (International). Singapore: McGraw Hill.
2. Hickman, C.P., Roberts, L.S. and Larson, A., 2001. Integrated Principles Of Zoology, 11th Edition (International). Singapore: McGraw Hill.
3. Pechenik, J.A., 2000. Biology of Invertebrates, 4th Edition (International). Singapore: McGraw Hill
4. Kent, G. C. and Miller, S., 2001. Comparative Anatomy of Vertebrates. New York: McGraw Hill.
5. Campbell, N.A., 2002. Biology 6th Edition, Menlo Park, California; Benjamin Company, Inc.

Books for Practical

1. Miller, S.A., 2002. General Zoology Laboratory Manual. 5th Edition (International) Singapore: McGraw Hill.
2. Hickman, C.P. and Kats, H.L., 2000. Laboratory Studies in Integrated Principles of Zoology. Singapore: McGraw Hill.

ANNEXURE-III

CURRICULUM FOR BS-4 YEARS PROGRAM IN ZOOLOGY

DEPARTMENT OF ZOOLOGY

MIRPUR UNIVERSITY OF SCIENCE AND TECHNOLOGY, MIRPUR

INTRODUCTION

Zoology as a subject is multidisciplinary in nature, involves the study of living beings and their genetic, morphological and physiological attributes, their surrounding environment, and their role in conservation of environment. Zoology is a combination of various disciplines such as Molecular Biology, Biochemistry, Biotechnology, toxicology, Genetics, Physiology, Ecology, Developmental Biology, Microbiology, Parasitology, Entomology, Freshwater Biology, Fisheries, and Wildlife etc. This subject has significant role in human resources development, food security, environmental conservation, sustainable development and ultimately in alleviation of poverty.

Eligibility Criteria: F. Sc. Pre medical/ A level (with Biology and Chemistry)

OBJECTIVES AND OUTCOMES OF TEACHING ZOOLOGY AT BS-4 YEARS

1. To impart knowledge about the major disciplines of Zoology. It will enable the students to understand the principles of organizations and inter-relationships in the biological systems with particular reference to animal diversity.
2. To teach different methods of exploration, investigation, organization of data and its utilization in practical life.
3. To train students for advanced studies and specialization on recently emerging technological and multidisciplinary fields such as Genetic Engineering, Biodiversity, Environmental Science, Wildlife and conservation, Fisheries and aquaculture, Pests and pest management, Biotechnology, etc. After completing the degree / students will be able to apply their knowledge to their respective fields effectively.
4. To equip students with knowledge and skills for better planning and management of animal resources, environment, health, medicine, agriculture and population in the country.
5. To develop the scientific culture and demonstrate professional skills in teaching /research/managerial positions in wide range of professions in national and international organizations.

Career Opportunities

After obtaining the BS degree in Zoology, the graduates will be able to get jobs in wide range of professions including:

Positions in various government and nongovernmental organizations, teaching and research, administration and management, aquaculture, fisheries, forestry, agriculture, biological control program, integrated pest management, lab diagnostics, poultry, plant protection, wildlife, livestock and other areas.

Pedagogy (Teaching - Learning Methodologies)

1. The courses will be delivered through lectures, seminars, practicals, discussions and field trips.
2. Teaching learning material will include text-books, reference books journals/periodicals, handouts and internet.
3. Using audio/ visual aids i.e., slides/ overhead transparencies / multimedia.

Assessment and Evaluation

Internal evaluation (left to the individual universities)

Mid term test

Seminars and Assignments

Final Examination

FORMAT/SCHEME OF STUDIES FOR 4-YEAR INTEGRATED CURRICULA FOR BS IN ZOOLOGY

STRUCTURE

Sr. No.	Categories	No. of Courses	Credit Hours
1.	Compulsory Requirement (No Choice)	09	23
2.	General Courses to be chosen from other departments	08	24
3.	Discipline Specific Foundation Courses	08	30
4.	Major Courses including Research Project / Internship	09	34
5.	Electives within the Major	09	24
	Total	**43**	**135**

- Total number of Credit hours 135
- Duration 4 years
- Semester duration 15-18 weeks
- Semesters 8

- Course Load per Semester 15-18 Cr hr
- Number of courses per semester 5-6

ANNEXURE-III

Scheme of studies for BS-4 Years (8 semesters) Program in Zoology w.e.f. 2018 & Onward

Duration	8-12 Semesters
Courses	129 Credits
Reseach Project/Special Papers	06 Credits
Total credits	**135**

YEAR-I

SEMESTER-I (Cr. 18)

Course Code	Course Title	Credits	Status
ENG-1107	English-I	3+0	Compulsory
PS-1117	Pakistan Studies	2+0	Compulsory
MAT-1115	Mathematics-I	3+0	Compulsory
BOT-1103	Botany-I	2+1	General
CHE-1104	Chemistry-I	2+1	General
ZOL-1101	Principles of Animal Life-I	3+1	Foundation-I
	Total Credits	**18**	

SEMESTER-II (Cr. 18)

Course Code	Course Title	Credits	Status
ENG-1207	English-II	3+0	Compulsory
ISL-1212	Islamic Studies / Ethics	2+0	Compulsory
STA-1220	Statistics/bioeconomics	2+1	Compulsory
BOT-1203	Botany-II	2+1	General
CHE-1204	Chemistry-II	2+1	General
ZOL-1201	Principles of Animal Life-II	3+1	Foundation-II
	Total Credits	**18**	

YEAR-II

SEMESTER-III (Cr. 19)

Course Code	Course title	Credits	Status
ENG-2107	English-III (Technical writing and presentation skills)	2+0	Compulsory
ARA-2101	Arabic	2+0	Compulsory
BOT-2103	Botany-III	2+1	General
CHE-2104	Chemistry-III	2+1	General
ZOL-2101	Animal Diversity-I	3+1	Foundation-III
ZOL-2102	Animal Form and Function-I	3+1	Foundation-IV
	Total Credits	**18**	

SEMESTER-IV (Cr. 16)

Course code	Course title	Credits	Status
COM-2205	Introduction to Computer	2+1	Compulsory
BOT-2203	Botany-IV	2+1	General
ZOL-2201	Animal Diversity-II	3+1	Foundation-V
ZOL-2202	Animal Form and Function-II	3+1	Foundation-VI
CHE-2204	Chemistry-IV	2+1	General
	Total Credits	**17**	

YEAR-III

SEMESTER-V (Cr. 17)

Course code	Course title	Credits	Status
ZOL-3101	Molecular Cell Biology	3+1	Major-I
ZOL-3102	Animal Physiology	3+1	Major-II
ZOL-3103	Genetics	3+1	Major-III
ZOL-3104	Environmental Biology	2+1	Major-IV
ZOL-3105	Evolution	2+0	Foundation-VII
	Total Credits	**17**	

SEMESTER VI (Cr. 17)

Course Code	Course title	Credits	Status
ZOL-3201	General Biochemistry	3+1	Foundation-VIII
ZOL-3202	Developmental Biology	3+1	Major-V
ZOL-3203	Principles of Animal Taxonomy	2+1	Major-V
ZOL-3204	Biostatistics	2+1	Major-VI
ZOL-3205	Paleontology	2+1	Major-VII
	Total Credits	**17**	

YEAR-IV

SEMESTER–VII (Cr. 15)

Course code	Course title	Credits	Status
ZOL-41**	Elective-I	2+1	Elective
ZOL-41**	Elective-II	2+1	Elective
ZOL-41**	Elective-III	2+1	Elective
ZOL-41**	Elective-IV	2+1	Elective
ZOL-41**	Elective-V	2+1	Elective
ZOL-4224	Reseaarch Project (research work will be started in semester VII and the credit will be given in semester VIII)		Major
	Total Credits	**15**	

SEMESTER-VIII (Cr. 17)

Course code	Course title	Credits	Status
ZOL-42**	Elective-VI	2+1	Elective
ZOL-42**	Elective-VII	2+1	Elective
ZOL-42**	Elective-VIII	2+1	Elective
ZOL-42**	Elective-IX	2+1	Elective
ZOL-42**	Elective-X	2+1	Elective
ZOL-4223	Comprehensive Oral Examination		S/U Basis
ZOL-4224	Research Project	0+6*	
*Note: students who opt special papers in lieu of Research will have to opt five elective			

papers from the field of specialization while research students will opt three elective papers which will be closely related to their field of research.			
	Total Credits	**15**	

18+ 18+18+17+17+17+15+15=135

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 1st SEMESTER

ZOL-1101 PRINCIPLES OF ANIMAL LIFE – I Cr. Hrs. 3+1

Aims and Objectives

The course aims to impart knowledge and understanding of:

1. The concept and status of Zoology in life sciences.
2. The common processes of life through its chemistry, biochemical and molecular processes.
3. The structure and function of cell organelles and how common animal cell diversified in various tissues, organs and organ systems.
4. Biochemical mechanisms eventually generating energy for animal work.
5. Animals and their relationship with their environment.

Course Contents

Scope of Zoology: Introduction; significance and applications of zoology; animal diversity; the scientific method; environment and world resources. **The Chemical Basis of Animal Life:** Brief introduction to biomolecules; carbohydrates, lipids, proteins, and nucleic acids. **Cellular Organization:** Structure of animal cells, cell membrane, cytoplasm and its organelles: ribosomes, endoplasmic reticulum, Golgi apparatus, lysosomes, mitochondria, cytoskeleton, cilia and flagella, centrioles and microtubules, and vacuoles; ribosomes, endoplasmic reticulum, the nucleus: nuclear envelope, chromosomes and nucleolus. **Animal tissues:** Types: epithelial, connective, muscle and nervous tissue; organs and organ systems. **Enzymes:** Structure, types; function and factors affecting their activity; cofactors and coenzymes. **Energy Harvesting:** Aerobic and anaerobic respiration: glycolysis, citric acid cycle and electron transport chain; fermentation, the major source of ATP. **Reproduction and Development:** Types; asexual and sexual, gametogenesis, fertilization, metamorphosis, zygote and early development. **Ecological Concepts:** Individuals and Populations: Animals and their abiotic environment; populations and limiting factors; Communities and Ecosystems: Community structure and diversity; interspecific interactions. Ecosystem, types, homeostasis, biomes, food chain, food web, energy flow and thermodynamics; biogeochemical cycles; Ecological problems; human population growth, pollution, resource depletion and biodiversity.

Practical:

1. Tests for different carbohydrates, proteins and lipids.

Note: Emphasis on the concept that tests materials have been ultimately obtained from living organisms and constituted their body.

2. Study of the prepared slides of epithelial tissue (squamous, cuboidal, columnar), connective tissue (adipose, cartilage, bone, blood), nervous tissue and muscle tissue (skeletal, smooth and cardiac).

   Note: *Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used.*

3. Preparation of blood smears.
4. Plasmolysis and deplasmolysis in blood.
5. Protein digestion by pepsin.
6. Ecological notes on animals of a few model habitats.
7. Field observation and report writing on animals in their ecosystem (a terrestrial and an aquatic ecosystem study).

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 12th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 6th Edition (International), 2005. Singapore: McGraw Hill.
3. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.
4. Miller, S.A. General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.
5. Hickman, C.P. and Kats, H.L., Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.
6. Molles, M.C. Ecology: Concepts and Applications. 6th Edition. 2005. McGraw Hill, New York, USA.
7. Odum, E. P. Fundamentals of Ecology. 3rd Edition. 1994. W.B. Saunders.Philadelphia.

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 2ND SEMESTER

ZOL-1201 PRINCIPLES OF ANIMAL LIFE-II Cr. Hrs. 3+1

Aims and Objectives

The course will imparts knowledge and understanding of:

1. Cell division and its significance in cell cycle.
2. Concepts and mechanisms of inheritance pattern, chromosome and gene linkage and molecular basics of genetics.

3. Animal behaviour and communication.
4. Theories of evolution, gene flow and mechanism of evolution with reference to animals and diversity.

Course Contents

Cell Division: Cell cycles: Mitosis and meiosis; control of the cell cycle. **Inheritance Patterns:** Mendelian genetics; inheritance patterns; gene, structure, chemical composition and types. **Chromosomes and Gene Linkage:** Eukaryotic chromosomes; linkage and crossing over; chromosomal aberrations. **Molecular Genetics: Cellular Control: DNA:** the genetic material; DNA replication in prokaryotes and eukaryotes; control of gene expression in eukaryotes; gene mutation; recombinant DNA and applications of genetic technologies. **Animal Behaviour:** Behaviour and its types, proximate and ultimate causes; anthropomorphism; development of behavior; learning; factors controlling animal behavior; communication; behavioral ecology; social behavior. **Evolution:** A Historical Perspective: Theories of evolution: Lamarckism and natural selection, neo larmarckism, Darwinism, and neo Darwinian. **Evolution and Gene Frequencies:** Hardy-Weinberg principle; evolutionary mechanisms: population size, genetic drift, gene flow, de Vries mutation theory and rates of evolution, polymorphism; species and speciation; molecular evolution; mosaic evolution.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles of Zoology, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. Comparative Anatomy Of Vertebrates. 2000. New York: McGraw Hill.
5. Campbell, N.A. Biology, 6th Edition. Menlo Park, California: 2002. Benjamin/Cummings Publishing Company, Inc.

Practical:

1. Study of mitosis in onion root tip.
2. Study of meiosis in grasshopper testis (students should prepare the slide).
3. Problem based study of Mendelian ratio in animals.
4. Multiple alleles study in blood groups.
5. Survey study of a genetic factor in population and its frequency.
6. Study of karyotypes of *Drosophila*, mosquito.
7. Study of cytochemical detection of DNA in protozoa and avian blood cell.
8. Study to demonstrate nervous or endocrine basis of behaviour (conditioned reflex or aggression or parental behavior).
9. Study to demonstrate social behaviour (documentary film be shown, honey bee, monkey group in a zoo).

Note for 1-2: Prepared microscopic and/or projection slides and/or CD ROM computer projections must be used).

Recommended Books

1. Miller, S.A. General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.
2. Hickman, C.P. and Kats, H.L. Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 3RD SEMESTER

ZOL-2101 ANIMAL DIVERSITY-I Cr. Hrs. 3+1

(Classification, Phylogeny and Organization of Invertebrates)

Aims and Objectives

The course is designed to provide students with:

1. Concepts of evolutionary relationship of animal kingdom.
2. Knowledge about animal kingdom, emphasizing their phylogenetic relationships and simple to complex mode of animal life.

Course Contents

Introduction: Architectural pattern of an animal, taxonomy and phylogeny, major subdivisions of animal kingdom. **Animal-Like Protists**: The Protozoa Evolutionary perspective; life within a single plasma membrane; symbiotic life-styles. Protozoan taxonomy: (up to phyla, subphyla and super classes, wherever applicable). Pseudopodia and amoeboid locomotion; cilia and other pellicular structures; nutrition; genetic control and reproduction; symbiotic ciliates; further phylogenetic considerations. **Multicellular and Tissue Levels of Organization** Evolutionary perspective: origins of multicellularity; animal origins. Phylum porifera: cell types, body wall, and skeletons; water currents and body forms; maintenance functions; reproduction. Phylum cnidaria (coelenterata) the body wall and nematocysts; alternation of generations; maintenance functions; reproduction and classification up to class. Phylum ctenophora; further phylogenetic considerations. **Triploblastics and Acoelomate Body Plan:** Evolutionary perspective; phylum platyhelminthes: classification up to class; the free-living flatworms and the tapeworms; phylum nemertea; phylum gastrotricha; further phylogenetic considerations. **Pseudocoelomate Body Plan**: Aschelminths Evolutionary perspective; general characteristics; classification up to phyla with external features; feeding and the digestive system; other organ systems; reproduction and development of phylum rotifera and phylum nematoda; phylum kinorhyncha. Some important nematode parasites of humans; further phylogenetic considerations. **Molluscan Success:** Evolutionary perspective: relationships to other animals; origin of the coelom; molluscan characteristics; classification up to class. The characteristics of shell and

associated structures, feeding, digestion, gas exchange, locomotion, reproduction and development, other maintenance functions and diversity in gastropods, bivalves and cephalopods; further phylogenetic considerations. **Annelida:** The Metameric Body Form Evolutionary perspective: relationship to other animals, metamerism and tagmatization; classification up to class. External structure and locomotion, feeding and the digestive system, gas exchange and circulation, nervous and sensory functions, excretion, regeneration, reproduction and development, in polychaeta, oligochaeta and hirudinea; further phylogenetic considerations. **Arthropods**: Blueprint for Success Evolutionary perspective: classification and relationships to other animals; metamerism and tagmatization; the exoskeleton; metamorphosis; classification up to class; further phylogenetic considerations. Crustaceans, Hexapods and Myriapods, general nature, classification, phylogeny and adaptive diversification. **Echinoderms**: Evolutionary perspective: relationships to other animals; echinoderm characteristics; classification up to class. Maintenance functions, regeneration, reproduction, and development in asteroidea, ophiuroidea, echinoidea, holothuroidea and crinoidea; further phylogenetic considerations; some lesser-known invertebrates: the lophophorates, entoprocts, cycliophores, and chaetognaths.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles Of Zoology, 15th Edition (International), 2011. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 8th Edition (International), 2011. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology Of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Practical

1. Museum study of representative phyla, permanent slide preparations
2. Study of *Euglena, Amoeba, Entamoeba, Plasmodium, Trypanosoma,*
3. *Paramecium* as representative of animal like protists. (Prepared slides).
4. Study of sponges and their various body forms.
5. Study of principal representative classes of phylum Coelenterata.
6. Study of principal representative classes of phylum Platyhelminthes.
7. Study of representative of phylum Rotifera, phylum Nematoda.
8. Study of principal representative classes of phylum Mollusca.
9. Study of principal representative classes of phylum Annelida.
10. Study of principal representative classes of groups of phylum Arthropoda.
11. Brief notes on medical/economic importance of the following:
12. *Plasmodium, Entamoeba histolitica, Leishmania*, Liverfluke, Tapeworm, Earthworm,
13. Silkworm, Citrus butterfly.

Recommended Books

1. Hickman, C.P. and Kats, H.L. Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.
2. Miller, S.A., General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.

ZOL-2302 ANIMAL FORM AND FUNCTION-I Cr. Hrs. 3+1

(A Comparative Perspective)

Aims and Objectives

The course aims to teach the students about:

1. Animals diversity adapted in different ways for their functions through modifications in body parts.
2. The diversity in integumentary, skeletal, muscular, nervous and sensory, endocrine, circulatory, respiratory, nutritive, excretory, osmoregulatory and reproductive systems according to strategies to survive in their specific conditions.
3. Organ systems, their specialization and coordination with each other and constantly changing internal and external environment, inside and outside the animal's body.
4. The basic structure of each system that determines its particular function.

Course Contents

Protection, Support, and Movement: Protection: the integumentary system of invertebrates and vertebrates; movement and support: the skeletal system of invertebrates and vertebrates; movement: non-muscular movement; an introduction to animal muscles; the muscular system of invertebrates and vertebrates. **Communication I: Nerves:** Neurons: structure and function; neuron communication: introductory accounts of resting membrane potential, action potential (nerve impulse) and transmission of the action potential between cells; invertebrate and vertebrate nervous systems: the spinal cord, spinal nerves, the brain, cranial nerves and the autonomic nervous system. **Communication II: Senses:** Sensory reception: baroreceptors, chemoreceptors, georeceptors, hygroreceptors, phonoreceptors, photoreceptors, proprioceptors, tactile receptors, and thermoreceptors of invertebrates; lateral-line system and electrical sensing, lateral-line system and mechanoreception, hearing and equilibrium in air, hearing and equilibrium in water, skin sensors of damaging stimuli, skin sensors of heat and cold, skin sensors of mechanical stimuli, sonar, smell, taste and vision in vertebrates. **Communication III:** The Endocrine System and Chemical Messengers: hormones chemistry; and their feedback systems; mechanisms of hormone action; some hormones of porifera, cnidarians, platyhelminthes, nemerteans, nematodes, molluscs, annelids, arthropods, and echinoderms invertebrates; an overview of the vertebrate endocrine system; endocrine systems of vertebrates, endocrine systems of birds and mammals. **Circulation, Immunity, and Gas Exchange:** Internal transport and circulatory

systems in invertebrates: characteristics of invertebrate coelomic fluid, hemolymph, and blood cells; transport systems in vertebrates; characteristics of vertebrate blood, blood cells and vessels; the hearts and circulatory systems of bony fishes, amphibians, reptiles, birds and mammals; the human heart: blood pressure and the lymphatic system; immunity: nonspecific defenses, the immune response; gas exchange: respiratory surfaces; invertebrate and vertebrate respiratory systems: cutaneous exchange, gills, lungs, and lung ventilation; human respiratory system: gas transport.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles Of Zoology, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. Comparative Anatomy of Vertebrates. 2001. New York: McGraw Hill.
5. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Practical:

1. Study of insect chitin, fish scale, amphibian skin, reptilian scales, feathers and mammalian skin.
2. Study and notes of skeleton of *Labeo, Rana tigrina, Varanus,* fowl and rabbit.

   Note: *Exercises of notes on the adaptations of skeletons to their function must be done.*
3. Earthworm or leech; cockroach, freshwater mussel, *Channa* or *Catla catla* or *Labeo* or any other local fish, frog, pigeon and rat or mouse and rabbits are representative animals for study in dissections.
4. Study of models or preserved brains of representative animals and notes on adaptations.
5. Study of nervous system of earthworm and a fish.
6. Study of endocrine system in an insect and a rabbit.
7. Study of different types of blood cells in blood smear of rabbit.
8. Study of heart, principal arteries and veins in a representative vertebrate (dissection of representative fish/mammals).
9. Study of respiratory system in cockroach or locust and a vertebrate representative (Model).

Recommended Books

1. Hickman, C.P. and Kats, H.L. Laboratory Studies in Integrated Principles of Zoology. 2000. Singapore: McGraw Hill.

2. Miller, S.A. General Zoology Laboratory Manual. 5thEdition (International), 2002. Singapore: McGraw Hill.

COURSE CONTENTS OF COMPULSORY/GENERAL FACULTY COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 4TH SEMESTER

ZOL-2201 ANIMAL DIVERSITY-II Cr. Hrs. 3+1

Aims and Objectives

The course provides knowledge and understanding about the different chordates, emphasizing their phylogenetic relationships.

Course Contents

Hemichordates and Invertebrate Chordates: Evolutionary Perspective: Phylogenetic Relationships; Classification up to subphylum or class where applicable; Further Phylogenetic Considerations. **Fishes**: Vertebrate Success in Water: Evolutionary perspective: phylogenetic relationships; survey of super class agnatha and gnathostomata; evolutionary pressures: adaptations in locomotion, nutrition and the digestive system, circulation, gas exchange, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations. **Amphibians**: The First Terrestrial Vertebrates Evolutionary perspective: phylogenetic relationships; survey of order caudata, gymnophiona, and anura. Evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction, development, and metamorphosis; further phylogenetic considerations. **Reptiles**: The First Amniotes Evolutionary perspective: cladistic interpretation of the amniotic lineage; survey of order testudines or chelonia, rhynchocephalia, squamata, and crocodilia; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, reproduction and development; further phylogenetic considerations. **Birds**: Feathers, Flight, and Endothermy Evolutionary perspective: phylogenetic relationships; ancient birds and the evolution of flight; diversity of modern birds; evolutionary pressures: adaptation in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and regulation, nervous and sensory systems, excretion and osmoregulation, reproduction and development; migration and navigation. **Mammals**: Specialized Teeth, Endothermy, Hair, and Viviparity: Evolutionary perspective: diversity of mammals; evolutionary pressures: adaptations in external structure and locomotion, nutrition and the digestive system, circulation, gas exchange, and temperature regulation, nervous and sensory functions, excretion and osmoregulation, behavior, reproduction and development.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles Of Zoology, 15th Edition (International), 2011. Singapore: McGraw Hill.

2. Miller, S.A. and Harley, J.B. Zoology, 8th Edition (International) 2010. Singapore: McGraw Hill.
3. Kent, G.C. and Miller, S. Comparative Anatomy Of Vertebrates. Latest Edition 2002. New York: McGraw Hill.
4. Campbell, N.A. BIOLOGY, 9th Edition. 2011. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Practical

1. Museum study of representative phyla
2. Study of a representative of Hemichordate and Chordate.
3. Study of representative groups of class Fishes.
4. Study of representative groups of class Amphibia.
5. Study of representative groups of class Reptilia.
6. Study of representative groups of class Aves.
7. Study of representative groups of class Mammalia.
8. Field trips to study animal diversity in an ecosystem.

   Note: *Preserved specimen and/or colored projection slide and/or CD ROM projection of computer must be used.*

Recommended Books

1. Hickman, C.P. and Kats, H.L. Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.
2. Miller, S.A. General Zoology Laboratory Manual. 5th Edition (International), 2002. Singapore: McGraw Hill.

ZOL-2402 ANIMAL FORM AND FUNCTION-II Cr. Hrs. 3+1

(CHORDATES: A Comparative Perspective)

Aims and Objectives

The course deals with the:

1. Basis of structure and functions of animal nutrition, digestion, homeostasis and temperature regulation.
2. It introduces the basic concepts in reproduction and development in animal kingdom.
3. Provides knowledge about the development of chordate body plan and fate of germinal layers.

Course Contents

Nutrition and Digestion: Evolution of nutrition; the metabolic fates of nutrients in heterotrophs; digestion; animal strategies for getting and using food, diversity in digestive structures of invertebrates and vertebrates; the mammalian digestive system: gastrointestinal motility and its control, oral cavity, pharynx and esophagus, stomach, small intestine: main site of digestion; large intestine; role of the pancreas in digestion; and role of the liver and gallbladder in digestion. **Temperature and Body Fluid Regulation:** Homeostasis and Temperature Regulation; The Impact of Temperature on Animal Life; Heat Gains and Losses; Some Solutions to Temperature Fluctuations; Temperature Regulation in Invertebrates, Fishes,

Amphibians, Reptiles, Birds and Mammals; Heat Production in Birds and Mammals; Control of Water and Solutes (Osmoregulation and Excretion); Invertebrate and Vertebrate Excretory Systems; How Vertebrates Achieve Osmoregulation; Vertebrate Kidney Variations; Mechanism in Metanephric Kidney Functions. **Reproduction and Development:** Asexual reproduction in invertebrates; advantages and disadvantages of asexual reproduction; sexual reproduction in invertebrates; advantages and disadvantages of sexual reproduction; sexual reproduction in vertebrates; reproductive strategies; examples of reproduction among various vertebrate classes; the human male reproductive system: spermatogenesis, transport and hormonal control, reproductive function; the human female reproductive system: folliculogenesis, transport and hormonal control, reproductive function; hormonal regulation in gestation; prenatal development and birth: the placenta; milk production and lactation. **Descriptive Embryology:** Fertilization; embryonic development: cleavage, and egg types; the primary germ layers and their derivatives; echinoderm embryology; vertebrate embryology: the chordate body plan, amphibian embryology, development in terrestrial environments, avian embryology, the fate of mesoderm.

Recommended Books

1. Hickman, C.P., Roberts, L.S. and Larson, A. Integrated Principles Of Zoology, 11th Edition (International), 2004. Singapore: McGraw Hill.
2. Miller, S.A. and Harley, J.B. Zoology, 5th Edition (International), 2002. Singapore: McGraw Hill.
3. Pechenik, J.A. Biology Of Invertebrates, 4th Edition (International), 2000. Singapore: McGraw Hill.
4. Kent, G.C. and Miller, S. Comparative Anatomy Of Vertebrates. 2001. New York: McGraw Hill.
5. Campbell, N.A. Biology, 6th Edition. 2002. Menlo Park, California: Benjamin/Cummings Publishing Company, Inc.

Practical:

1. Study of excretory system in an invertebrate and a vertebrate representative (Model).
2. Study of nutritive canal in an invertebrate and a vertebrate representative (Dissection).
3. Study of male reproductive system in an invertebrate and a vertebrate representative (Dissection).
4. Study of female reproductive system in an invertebrate and a vertebrate representative (Dissection).
5. Study of hormonal influence of a reproductive function (Model).
6. Study of preserved advanced stages of avian and mammalian development for amniotic membranes and placenta (Model).
7. Study of stages in the development of an Echinoderm.
8. Study of early stages in the development of a frog, chick and a mammal.

Note for 9-10: Prepared slides and preserved specimen and/or projection slides and/or CD ROM computer projections may be used.

Recommended Books

1. Hickman, C.P. and Kats, H.L. Laboratory Studies In Integrated Principles Of Zoology. 2000. Singapore: McGraw Hill.
2. Miller, S.A. General Zoology Laboratory Manual. 5thEdition (International), 2002. Singapore: McGraw Hill.

COURSE CONTENTS OF COMPULSORY FACULTY COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 5TH SEMESTER

ZOL-3101 MOLECULAR CELL BIOLOGY Cr. Hrs. 3+1

Aims and Objectives

The objectives of the course are to impart knowledge about the animal cell and its complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms. The 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 with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus, Mitochondria, Lysosome, peroxisome, glycoxysome. **Nucleus,** chromatin, heterochromatin, euchromatin, Replication (mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes, Transcription (variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA, RNA splicing, split genes, concept of Ribozymes and posttranscriptional processing), RNA transduction, Genetic code, point mutations, Translation. Control of gene expression in prokaryotes.

Practical:

1. Isolation of chromosomal DNA and RNA from bacteria, fungi and yeast.
2. Detection and quantitative determination of chromosomal DNA and RNA through gel electrophoresis techniques.
3. Isolation of plasmid from bacteria, fungus and yeast.

Recommended Books

1. Damnell Jr .J; Lodisch, H. and Baltimore, D (1990). Moleculer Biology, Scientific American Inc.N.Y.
2. Alberts B., Brary, D., Lewis, J., Raff, M., Roberts, Kand Watson, J.D. (1989). Moleculer Biology of Cell.Garland Publishing Inc. New York.
3. De Robertes, E.D.P. And De Robertis Jr, E.N.F. (1987). Cell and Moleculer Biology. Laea & Febiger New York
4. Karp, J. Cell and Molecular Biology, Concepts and Experiments, 2005. John Willey and Sons, INC.

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

ZOL-3102 ANIMAL PHYSIOLOGY Cr. Hrs. 3+1

Aims and Objectives

The course aims to:

1. Understand basic physiological mechanisms relating to membrane excitability, nerve and muscle, receptor function.
2. Understand neuro-endocrine coordination and secretions of glands.
3. Know the physiology of heart, hemodynamic system and kidney function.
4. Understand the digestive physiology and nutritive functions of gut.
5. Understand physiological regulation of temperature and its maintenance

Course Contents

Central themes in Physiology: Homeostasis, Concepts of conformity and regulation; physiological adaptations. **Neuro-muscular physiology:** Cellular homeostasis, resting and action potential, synaptic transmission, muscle contraction, general sensory mechanism, cutaneous sensation, audition, vision, taste, olfaction, the motor control system, sleep and consciousness. 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. **Cardiovascular Physiology:** Vessels, heart, electrocardiography, cardiac rate, rhythm, and conduction disturbances, heart as a pump, cardiodynamics, hemodynamics, cardiac output and venous return, control of cardiovascular system, responses to stress. **Respiratory physiology:** Respiratory mechanics, gas exchange between atmosphere and the body, gas transport, pulmonary circulation, respiratory control, hypoxia. **Renal Physiology:** Body fluid compartment, renal tubular function, renal clearance, glomerular filtration and GFR, reabsorption and secretion, composition of urine, formation of dilute and concentrated urine, effect of ADH, Aldosterone and Atrial Natriuretic Factor on renal physiology. **Gastrointestinal Physiology:** Digestive system, the oral cavity, composition of saliva, pharynx, oesophagus, the stomach, regulation of gastric juice, small intestine, liver, regulation of bile, pancreatic and intestinal enzymes and their regulation, the colon, absorption of nutrients. **Endocrine Physiology:** General features of hormones, types of hormone action, basic concepts of endocrine control, endogenous opioid peptides, pituitary gland, thyroid gland, parathyroid hormones, calcitonine, Vitamin D. Adrenal Medulla, Adrenal cortex, Testis, Ovary, Endocrine placenta, Endocrine Pancreas. **Temperature Regulation:** Temperature classification of animals; Temperature relation of ectotherms in freezing, cold, warm and hot environment; costs and benefits of ectothermy; Temperature relations of heterotherms and endotherms; Dormancy: Sleep, Torpor, Hibernation and Estivation.

Practical:

1. **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.
2. **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.
3. **Cardiovascular Activity:** Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.
4. **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.
5. **Endocrine and Reproductive Mechanisms:** Effect of insulin on glycemia, study of stages in estrous cycle.
6. Study of RBCs count and TLC

Recommended Books

1. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert Animal Physiology: Mechanisms and Adaptations, 5th Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. Principles of Physiology, 3rd Edition. 2000. St. Lious, Mosby.
4. Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, 10th Edition. 2000. W.B. Saunders Company, Philadelphia.
5. Withers, P.C. Comparative Animal Physiology. 1992. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K. Animal Physiology, Adaptation And Environment, 5th Edition. 1997. Cambridge University Press, Cambridge.

ZOL-3103 GENETICS Cr. Hrs. 3+1

Aims and Objectives

The continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc. The process of continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment. These concepts will be imparted to the students in this course.

Course Contents

Classical genetics: Scope and importance of genetics, gene concept (classical and modern), **multiple alleles,** blood groups and coat color in rabbits, **Chromosomal basis of inheritance:** interaction of genes, chromosomal changes (euploidy, aneuploidy, structural changes), Karyotyping-Normal human chromosome complement. Pedigree Analysis. **Sex-determination and sex-linkage:** Sex determination in animals and humans, linkage, recombination and chromosome mapping in eukaryotes, quantitative inheritance. genetics of viruses, bacteria, transposons. **Molecular genetics** – analysis and techniques of molecular genetics (elements of genetic engineering), genetic basis of cancer, genetic control of animal development, the genetic control of the vertebrate immune system, complex inheritance patterns. **Human Genetics:** Autosomal anomalies, Pseudoautosomal genes, (eg. Down's syndrome, Edward's syndrome and Cri Du Chat syndrome), Single gene disorders Gene mutation and disorders (Brief mention) Autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as phenylketonuria, alkaptonuria). Definition - characteristics criss-cross inheritance. Multifactorial disorders - Polygenic traits - Cleft lip and cleft palate, Sex-linked and sex-influenced inheritance: Haemophilia and colour blindness. Sex chromosomal anomalies (Klinefelters syndrome, and Turner's syndrome). **Prenatal Diagnosis:** (Amniocentosis) and choriovillus sampling-Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics. **Population genetics**–Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

Practical:

1. Mitosis (Onion root tips.)
2. Meiosis (Grass hopper testes)
3. Blood groups.
4. Salivary gland Chromosomes of *Drosophila melanogaster*
5. General morphology of *Drosophila melanogaster*
6. Human Pedigree analysis problems
7. Human Genetics problems
8. Probability problems. Tossing of coins. X^2 test
9. Study of transformed bacteria on the basis of antibiotic resistance.

Recommended Books

1. Snustad, D.P. and Simmons, M.J. Principles of Genetics. 3rd Edition, 2003. John Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. Principles of Genetics. 7th Edition, 2001.WCB publishers USA.
3. Gardener, E.J., Simmons, M.J. and Snustad, D.P. Principles of Genetics. 1991. John Wiley and Sons Ins. New York, USA.
4. Stickberger, M.W, (1985). Genetics, McMillan, N.Y.
5. Herskowitz, I.H. (1985). Genetics, Little Brown, Bostan.

6. White-House, H. L. K. (1965). Towards an understanding of mechanism of heredity
7. Crow, J.F. (1976). Genetics notes Burgess Publishing Company, Minneapolis.
8. Mays L.L. (1989).Genetics –A Molecular Approach, McMillan and Company N.Y.
9. Lewin, B. (2000). Gene VIII, Oxford University Press, UK.

ZOL-3104 ENVIRONMENTAL BIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The main goal of this course is to enable the students to develop strong expertise in contemporaneous themes in environmental biological research and to be able to discuss these issues in a broad context. The students will be able to think and discuss about advanced topics in ecosystem ecology, types, interactions, pollution types and causes and their solution.

Course Contents

Concept of living **environment and global ecosystem** (Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecosphere). Urban ecosystem. **Interactions in ecosystem**, Concept of energy flow and biogeochemical cycles. Disturbance in ecosystem. Environmental resources and their conservation (Mineral resources, Agriculture and forestry, Agriculture land use, Range management, Desalination and Weather modification).

Environmental pollution: Air pollution. Major and minor atmospheric pollutants (CO2, CO CS2, O3, Smog and PAN1 NOX NH3 Ethylene, dust, sources origin dispersion and impact of these pollutants on human, Crops & Forest. Water pollution. Domestic and industrial effluents.

Energy: Various forms of energy, utilization and environmental impact, energy crises. Radiation Biology, Space Biology, Exobiology, Extra biosphere environment. High Altitude Ecology, Ocean Ecology. Contemporary environmental themes (Zone depletion, Green house effect, global warming, Acid Rain, desertification, deforestation).

Practical:

1. Analysis of aquatic and terrestrial ecosystem.
2. Pollution dynamics of grasshoppers.
3. Capture and recapture methods.
4. Adaptive feature of animals in relations to food and environment.
5. Food chain of local wild birds in various seasons.
6. Study of polluted areas and their impact on animal and plant life.
7. Analysis of urban (polluted) air for NO_2, SO_2 and O_3 pollutants and comparison with back ground rural air.

8. Effect of industrial effluents and smoke on animal life.
9. Analysis of polluted and fresh water for various effluents (CI, CO_3-HCO_3-, NO_3-, BOD, COD, pH, EC), total soluble and suspended solids, etc.
10. Impact of radiation on microbes and plant life.
11. Effect of noise on animal behaviour, a survey of endangered species, Visit to National Parks.

Recommended Books

1. Odum, E.P.,(1987). Fundamental of Ecology ,W.B. Saunders
2. Smith,R.L.,(1980). Ecology and Field Biology, Harper and Row.
3. Bebel,BJ., (1981).Environmental Science, Prentice Hall Inc.
4. Balley, J.A., (1986). Principles of Wild Life Management, John Wiley.
5. Ali S. &Ripley S.D., (173). A Handbook of Birds of India & Pakistan, Oxford University Press, Landon.
6. Robert, T.J., (1991). The birds of Pakistan Vol.1.Oxford University Press.
7. Robert, T.J. (1992) the bird of Pakistan. Vol.11.oxford University Press.

ZOL-3105 EVOLUTION Cr. Hrs. 2+0

Aims and Objectives

This course intends to the understandings of basic concepts (definition, types) and history of evolution, understanding and analysis of most influential theories of evolution, phenomenal processes that control, regulate evolution and correlate modern knowledge and concepts of phenomenal processes and theories of evolution.

Course Content:

The nature and origin of life. Theories to explain the diversity of life: Lamarckism, Darwinism and special creation. The present status of these theories. The species as key stone of evolution. Species Concepts, Kinds of Species. 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-evolution)-allometry, orthogenesis, adaptive radiation.

Modern concept of Natural Selection: Levels of action, direction, intensity, laboratory and field experiments to demonstrate the action of Natural Selection. Action of Natural Selection leading to convergence, radiation, regression and extinction.

Recommended Books

1. Dobzhansky,T., (1970).Genetics of evolutionary process, Columbia University Press, NewYork.

2. Sheppard, P.M. (1958).Natural Selection and Heredity, Hutchison University Library, London.
3. Dobzhansky, T.Genetics and the Origin of Species, Columbia University Press, NewYork.
4. Mayr, E. Populations, Species and Evolution, Harvard University Press.
5. Moody, P. A., (1989). Introduction to Evolution, Harper and Row Publishers, New York.
6. Caln, A. J.(1963). Animal Species and their Evolution, Hutchinsons University Library, London.

COURSE CONTENTS OF COMPULSORY FACULTY COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 6TH SEMESTER

ZOL-3201 GENERAL BIOCHEMISTRY Cr. Hrs. 3+1

Aims and objectives

- The course will provide (in depth) knowledge about the polymerized organic compounds of life.
- The dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It will deal with the inter-conversion and is performed by various tools called as enzymes.
- Thus, in this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Learning outcomes

- Student will be able to demonstrate the polymerized organic compounds of life, the chemical basis of life and various mechanisms involved in harvesting of energy for growth, duplication and other necessary functions of life.
- Students will be able to develop research skills and knowledge of research techniques and instrumentation by means of class lectures and lab practices.
- Students will be able to perform basic biochemical tests including detection of carbohydrates, amino acids, solubility of lipids and enzyme activity.

Course Contents

Amino acids, peptides and proteins: standard amino acids, their structure and classification; acid-base properties of amino acids and their titration curves; peptides, their ionic behavior and amino acid composition, cytochrome c; Macromolecular separation techniques in biochemistry; ion exchange chromatography; isoelectric focusing; density gradient centrifugation. **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 enzyme activity. **Carbohydrates:** classification, types, important characteristics and structure of carbohydrates; history of developments in structure of glucose; monosaccharides; cyanohydrin 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 of 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 of glycogen and starch; regulation of glycogen metabolism; utilization of dietary polysaccharides (starch) and disaccharides (sucrose and galactose). **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. **Lipid metabolism:** oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis and 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) multienzyme complex; biosynthesis of unsaturated fatty acids. 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. Neucleotide metabolism.

Recommended Books

1. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 3rd Edition, 2000. McMillan Worth Publishers, New York.
2. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. Harper's Biochemistry, 25th Edition, 2000. McGraw Hill, New York.
3. Voet. D., Voet, J.G., and Pratt, C.W. FUNDAMENTALS OF BIOCHEMISTRY, 1999. John Wiley and Sons, Inc., New York.

4. Zubay, G. Biochemistry, 4th Edition, 1995. Wm. C. Brown Publishers, Inc., Oxford, England.
5. Lubert, S. Biochemistry, 4th Edition, 1995. W.H. Freeman & Company, New York.
6. McKee, T. and McKee, J.R. Biochemistry, The Molecular Basis Of Life. 3rd Edition, 2003. McGraw Hill.

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

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

Recommended Books

1. Plummer, David T. An Introduction to Practical Biochemistry, 1990. 4th Edition McGraw-Hill Book Company, London.
2. Wilson, K & Walker, J. Practical Biochemistry: Principles and Techniques, 4th Edition, 1994. Cambridge University Press.

ZOL-3202 DEVELOPMENTAL BIOLOGY Cr. Hrs. 3+1

Aims and Objectives

The course will provide detailed knowledge about the principal features of development, cellular basis of morphogenesis, mechanisms of cellular differentiation and concepts of induction in development. It will provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis. The concept related to the theory in Developmental Biology will be practically

demonstrated in this course. In the continuity of the animals during reproduction following the union of the traits from the parents in their gametes, the zygote proceeds through enormous phenomena of development up to their emergence resembling to the parents. The concepts of all these developmental mechanisms will be communicated to the students in this course.

Course Contents

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 nd 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.

Practical

Study of structure of gametes in some representative cases, i.e., fish, frog, 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. Study of nematode larvae, developmental stages of mosquito.

Recommended Books

1. Gilbert, S. F. Developmental Biology, 2010. Sinauer Associates, Sunderland, MA.
2. Balinsky, B. I. An Introduction to Embryology, 1985. Saunders.
3. Saunders, J. W. Developmental Biology, 1982. McMillan and company.
4. Oppenheimer, S.S. Introduction to Embryonic Development, 1984. Allen and Bacon.
5. Ham, R. G. and Veomett, M. J. Mechanism of Development. 1980. C. V. Mosby Co.
6. Klaus, K. Biological Development. 2nd Edition, 2001.McGraw Hill.

ZOL-3203 PRINCIPLES OF ANIMAL TAXONOMY Cr. Hrs. 2+1

Aims and Objectives

The course is designed to provide in knowledge about the importance and history of animal systematics with basic rules and regulations about the identification and naming of organisms.

Course Contents

Definition and basic concepts of taxonomy, systematics and classification. Importance and application of systematics in animal science, brief history of taxonomy; Forms of classification: Taxonomic categories and hierarchies: The Linnaean Hierarchy; 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; The basis and criteria of classification, Nomenclature (ICZN). Kinds of evidences, Similarity and Homology, Criteria of Homology, Serial Homology, Criteria for primitive and specialized characters, Parallelism. Monophyly and Polyphyly, Grades and Clades, Divergence and Diversity, Splitting and Lumping, Evolutionary basis of taxa. International codes of taxonomy, Systematics publications, Principle of priority and validity of names. Taxonomic Procedures: Taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.

PRACTICAL

Study of preserved vertebrates and invertebrate species and their classification up to class level. Collection and preservation techniques, Identification of common animal species with the help of Key. Preparation of keys for the identification of specimens.

Recommended Books

1. V. C. Kapoor (2001) Principles and Practices of Animal Taxonomy (2nd edition), Science Publishers.
2. Simpson, G.G. (1990). Principles of Animal Taxonomy, Columbia University Press, N.Y.
3. Huxley, E. (latest edition). New Systematics, Oxford University Press.
4. Mayr, E. (latest edition). Animal species and evolution, Harvard University Press.
5. Scheuk and McMster. (Latest edition). Procedure in Taxonomy, Stanford University Press.
6. Mayr, E. and Ashlock, P.D. (latest edition). Principles of Systematics Zoology, McGraw Hill Inc. New York.
7. Rissm G.G. (latest edition). Taxonomy and Ecology. Addison-Wesley Publishing Co. Reading, Massachusetts.
8. Heywood, V.H. (latest edition). Taxonomy and Ecology. Academic Press, London.
9. Whili, M.J.D. (latest edition). Modes of Speciation, W. H. Freeman and Co. San Francisco.

ZOL-3204 BIOSTATISTICS Cr. Hrs. 2+1

Aims and Objectives

1. 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.
2. After this course students will be able to apply basic statistical procedures for analysis of data for practical and research.

Course Contents (Theory & Practilccal)

Introduction and scope, use of statistics in biology. Population and sample, Stages of research, **Types of data**: methods of data collection. Data arrangement and presentation, formation of 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. **Handling of multiple samples**: Analysis of variance and LSD. **Correlation and regression**. Experimental designing, planning of an experiment, replication and randomization.

Practical

Analysis of given data by T test, Chi square test, Correlation, regression and one way ANOVA applying any of the available statistical software preferably SPSS or R Program

Recommended Books

1. Bailey, N.T.J. (1981). Statistical Methods in Biology, English University Press.
2. Campbell, R. C. Statistics for Biologists. 1989. Cambridge University Press.
3. Forthofer R N. 2011. Biostatistics: a guide to design, analysis and discovery. Elsevier Publishers.
4. Geoffery, R. Norman, David L. Streiner. Biostatistics: The Bare Essentials. 2000. B.C. Decke Inc.
5. Gerry, P. Quinn, Michael J. Keough, Experimental Design and Data Analysis for Biologists. 2002. Cambridge University Press.
6. Mariappan P. 2013. Biostatistics: an Introduction (LPE). Pearson, New York, New Dehli
7. Mather, K. (1960). Statistical Analysis in Biology. Methuen.
8. Mishra, B.N. (1982). Introduction to Practical Biostatics.
9. Montgomery D C. 2014. Design and Analysis of Experiments 8th Ed. Wiley Publishers, New Dehli
10. Muhammad F. 2005. Statistical methods and Data analysis. Kitab Markaz, Faisalabad
11. Simpson, G.G., Roe, A. and Lewonhtin, R.C. (1960). Quantitative Zoology, Harcourt Bruce and Company.

12. Sokal, R.R. and Rohlf, F.J. (1973). An Introduction to Bio-statistics, Toppan.

13. Walpole, R E. 1982. Introduction to statistics. McMillon Publishing Co New York

ZOL-3205 PALEONTOLOGY Cr. Hrs. 2+1

Course Objectives

- ✓ The course imparts knowledge and concepts of Paleontology mainly based on the past fossil records.
- ✓ The fossil records also provide the information regarding the presence and distribution of animals in the past eras.
- ✓ This contents enable students to relate the studies of past environment and present Climatic Changes.

Learning Outcomes

- ✓ The course will impart knowledge of origin of life, and forces responsible for evolutionary changes and present status of paleontology.
- ✓ The students will be able develop strong paleontological observations in students.
- ✓ The Students will be able to understand evolutionary processes with special focus on GTS.

Course Contents

Introduction to paleontology. Disciplines in paleontology. Core branches of paleontology and their interrelationships. Fossils,Types of Fossils, Nature of fossils. Fosslization. Uses of Fossils. Paleoecology, Micropaleontology, Paleomagnetism. Index fossils and their use in biostratigraphy with special reference to Pakistan. Study of salt range with special reference to Pakistan. Pre-Cambrian life, Post-Cambrian life cambrian Explosion Paleo-proxy Record . Earth, Shells of earth; (atmosphere, hydrosphere, biosphere and lithosphere). Rock, types of rocks (lgneous rocks, sedimentary rocks and metamorphic rocks); Rock cycle, Significance of Rocks. Petrology, Study of Minerals. Geological time scale. Geochronometry and Application of Geo-chronometry in paleontology. Radiometric dating methods (Uranium/Lead dating, radiocarbon dating, methods). Uranium/lead dating, the use of zircon, Environmental issues related to Geomorphology (effect on Fossils Distribution): with special emphasis on plate Tectonics, Volcanoes, Earthquakes,Tsunami. Present status of paleontology and its practical application.

Practical:

1. Study of mold, casts, pseudomorphs, petrified fossils, imprints, foot prints
2. Preparation of Artifical Replicas by kneaded clay.
3. Study of fossils, coelenterates, crustaceans, brachiopods; trilobites molluscs and echinoderms.

4. Study of vertebrates fossils of evolutionary importance e.g. horse, elephant, camels and primates.
5. Isolation of Micro-fossils by different techniques and microscopic visualization.
6. Study and identification of igneous, sedimentary and metamorphic rocks.
7. Tree ring dating by Radio active isotopes of Carbon.
8. Use of different Radiometric technique; radiocarbon dating of ground water -practical applications.
9. Field survey of Archaeological site and Note down common features of site.

Recommended Books

1. Michael Foote and Arnold I. Miller, 2007. Principles of Palaeontology (3rd Ed.) Freeman and Company.
2. Michael, J.B. and David, A.T. Harper, 2009. Palaeobiology and the fossil record (3rd Ed.). Wiley Blackwell.
3. Dunbar, C.O. (1969). Historical Geology. JohnWiley & Sons, N.Y.
4. Brouwer, A. (1977). General Paleontology .Oliver and Boyd, London.
5. Gilbert, E.H. (1980). Evolution of Vertebrates, JohnWiely, New York.
6. Moore, R.C., Lallcker, G.C. and Fisher, A.G. Invertebrates Fossils. McGraw Hill, N.Y.
7. Romer, A. S. (1958). Vertebrates Paleontology. The University of Chicago Press.
8. Shrock, R.A. and Twenhoefel, W.W. (1953). Principles of invertebrate Paleontology McGraw, Hill, New York.
9. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. Evolution. 1973. W.H. Freeman and Company.
10. Sheppard, P.M. (1958). Natural Selection and Heredity, Hutchison University Library, London.
11. Dobzhansky, T. Genetics and the Origin of Species, Columbia University Press, New York.
12. Mayr, E. Populations, Species and Evolution, Harvard University Press.
13. Moody, P. A. (1989). Introduction to Evolution, Harper and Row Publishers, New York.
14. Caln, A. J. (1963). Animal Species and their Evolution, Hutchinsons University Library, London.

LIST OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY VII SEMESTER

Course code	Course Title	Lec. Hrs	Lab. Hrs	Credit Hrs.
ZOL-4101	Zoogeography	2	1	3
ZOL-4102	Reproductive Physiology	2	1	3
ZOL-4103	Clinical Endocrinology	2	1	3
ZOL-4104	Neurophysiology	2	1	3
ZOL-4105	Immunology	2	1	3
ZOL-4106	Hematology	2	1	3
ZOL-4107	Biotechnology-I	2	1	3
ZOL-4108	Biotechnology-II	2	1	3
ZOL-4109	General Toxicology	2	1	3
ZOL-4110	Human Genetics	2	1	3
ZOL-4111	General Microbiology	2	1	3
ZOL-4112	General Parasitology	2	1	3
ZOL-4113	Invertebrata	2	1	3
ZOL-4114	General Entomology	2	1	3
ZOL-4115	Principles of Fish Biology	2	1	3
ZOL-4116	Fisheries & Aquaculture	2	1	3
ZOL-4117	Limnology-A	2	1	3
ZOL-4118	Principles of Herpetology	2	1	3
ZOL-4119	Biodiversity	2	1	3
ZOL-4120	Histology	2	1	3
ZOL-4121	Biological Techniques	1	2	3
ZOL-4122	Research Methodology	2	1	3
ZOL-4224	Research Project	0	0	0

C

OURSE CONTENTS OF ELECTIVE COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 7TH SEMESTER

ZOL-4101 ZOOGEOGRAPHY Cr. Hrs. 2+1

Aims and Objectives

The course imparts knowledge and concepts of evolution based distribution of animals on the globe. This course provides information on the distribution of animals and their associations in the past; thus, to rationalize their relationship in the present time.

Course Contents

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), Factors affecting animal distribution. Barriers and dispersal. Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaearctic, Nearctic region), Oriental, Ethiopian, Australian, and Neotropical Region. Insular fauna; (Continental, Oceanic and Ancient Islands). Palaeogeography (Theories of Continental drift and Plate tectonics). Zoogeography of Pakistan: ecoregions, fauna of land and sea.

Recommended Books

1. Darlington, P.J. (1963). Zoogeography, the Geographical Distribution of Animals. John Wiley, N. Y.
2. Parker, Hesse, Allee and Schmidt. (1963). Ecological Animal Geography. John Wiley, N.Y.
3. DeBeaufort, L.F. (1951). Zoogeography of the Land and Inland Waters. Sidgwick and Jackson, London.
4. Ekman, S. (1967). Zoogeography of the Sea, Sidgwick and Jackson, London.
5. Jillies, (1974). Introduction to Zoogeography, London.
6. Muller, P. (1974). Aspects of Zoogeography. W. Junk Publishers, Hague.
7. Ali, S.S. Palaeontology, Zoogeography and Wildlife Management. 1999. Nasim Book Depot, Hyderabad, India.

ZOL-4102 REPRODUCTIVE PHYSIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of the subject is to learn about the essential reproductive, histology and physiology of reproductive organs and other relevant organs to integrate this knowledge to study processes that regulate metabolic processes in the body. In

addition it includes the study processes of reproduction and examples of bodily dysfunction and disease that illustrate the basic principles of normal physiology through the absence of normal function.

Course Contents

Note: The emphasis shall be mainly on human being and poultry.

Cytological and genetic basis of sex. Female and male reproductive tracts, morphology and histology. Differentiation of sex and role of hormones. Gonadotropins, their chemistry and physiological characteristics. Mammalian ovary. Mammalian female reproductive cycles and its controlling mechanisms. Oogensis and Folliculogenesis. Brief study of avian ovary and its functional mechanisms. Mammalian testis. Spermatogenesis in man and domestic animals. Accessory sex organs in male mammals. Fertilization, early development, embryo transfer and implantation. Hormonal mechanisms in pregnancy, parturition. Mammary Gland development, milk synthesis and lactation. Nutrition and reproductive efficiency. Anti-fertillity mechanisms in human. Sterility causes in domestic animals.

PRACTICAL

Study of male and female reproductive tracts in a mammal and a bird. Histology of different parts of the tract. Study of Spermatogenesis and folliculogenesis. Study of reproductive cycles in a mammal. Experiments on nutrition and reproductive efficiency in mammals and birds.

Recommended Books

- Parkes, D.A. Marshalls, Physiology of Reproduction (Vol. I, II & III).
- Young, W. C. Sex and Internal Secretion (Vol. I & II), Williams and Wilkins Co. London
- Cole, H.H. and Cupps, P. T. (1977). Reproduction in Domestic Animals, Academic Press, New York.
- Bearden H.J. and Fuquay, (1980). Applied Animal Reproduction, Reston Publishing Co. Inc. Reston.
- Finn, C.A. (1979-81). Oxford. Review of Reproductive Biology (Vol. I, II & III), Clarendon Press, Oxford.
- Hafez, E.S.E. (1982). Reproduction in Farm Animals, Lea and Febiger.

ZOL-4103 CLINICAL ENDOCRINOLOGY Cr. Hrs. 2+1

Aims and Objectives

To study that degeneration disease are the results of alterations in biochemical homeostasis regulated by endocrine system.

Course Contents

Functional pathology of Endocrine Glands: Neuroendocrine disorders of gonadotropin, prolactin, growth hormone, corticotrophin regulation; Pituitary disorders: Prolactinomas, Acromegaly, Cushing's syndrome. Diabetes insipidus, hypo- and hyper-tonic syndromes; Thyroid diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper-function; Disorders of Adrenal medullary function; Disorders of Ovarian function and

hormonal therapy; Abnormalities of Testicular functions and hormonal therapy. Fuel homeostasis: Glucose homeostasis and Hypoglycemia; Diabetes mellitus; Disorders of lipoprotein metabolism; Eating disorders: Obesity, Anorexia nervosa and Bulimia nervosa. Development and Growth: Disorders of growth and puberty. Endocrine Hypertension. Poly-endocrine Syndromes. Hormones and Cancer: Hormonal effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy. Geriatric Endocrinology: Endocrine and associated metabolism in aging: specifically thyroid, glucose and calcium homeostasis.

PRACTICAL

Studies of disorders of pituitary by observing anatomical and histological features. Studies of thyroid status in deficient and excess hormone functions; Studies of type 1 and type 2 diabetes mellitus: epidemiology of the types in population, studies of management of the type 2 diabetes mellitus. Model studies of disorders of Ovarian and Testicular disorders; Model studies of obesity and anorexia; Studies of status in puberty and aging.

Recommended Books

1. Greenspan, F.S. and Strewaler, G.J. 2002 Basic and Clinical endocrinology, 5th Edition. Prentice Hall International lnc. London.
2. Wilson, J.D., D.W., Kronenberg, H.M. and Larsen, P.R., 2008. Wlliams Textbook of endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. 2001. Endocrinology, Vol. I, II & III, 4th edition. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An Interactive Approach. Blackwell Science Inc. London.

ZOL-4104 NEUROPHYSIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course aims to understand the basic physiological mechanisms relating to the body coordination through cell membran, nerve, muscle excitation and receptor function.

Course Contents

Foundation of excitability at cell membrane level: Membranes, channels and transport. The physical basis of neuronal function: Membrane excitation, resting and action potentials. Communication along and between neurons: Propagation of action potential, synaptic transmission, pre and postsynaptic mechanisms. Neurotransmitters: synthesis, release and their fate. Learning related changes at synapse. Neurochemical basis of behaviour. Organization of sensory receptors. Physiological basis of receptors functions: Mechanoreceptors, photoreceptors, chemoreceptors, Thermoreceptors, Electroreceptors and Nocireceptors.

PRACTICAL

Experiments demonstrating: Nervous organizations in vertebrates (mammals), Potentials particularly the nerve impulse. Nervous regulation of functional system.

Recommended Books

1. Aidley, J. David, 1998. The Physiology of excitable cells. Cambridge University Press, Cambridge, U.K.
2. Ganong, W.F., 2000. Review of Medical Physiology. Prentice-Hall International Inc., London.
3. Randall, D., Burggren, W. And French, Kathleen, 1998. W.F. Freeman and Company, New York.

ZOL-4105 IMMUNOLOGY Cr. Hrs. 2+1

Aims and Objective

The aim of the course is to provide a greater understanding of the role of the immune system in preventing human disease and to focus on how deficiencies in immunity can result in disease susceptibility; in addition, students study the main subject areas in biosciences and medically related research; these subject areas include biochemistry, genetics, cell and molecular biology, anatomy and physiology as related to human health disease and treatment.

Course Contents

Cell mediated and humoral immunity, immunoglobulins, and the synthesis of antibody. Theories of antibodies synthesis. Antigenicity interaction of antigen and antibody. Hypersensitivity and its types with mechanism, classical and alternate compliment sequence, immunology in transplantation, autoimmunity to infections, immune deficiency diseases. Application of immunological phenomena in experimental biology.

PRACTICAL

Antigens and elicitation of immune response. Experiments on methodology that employs immunological procedure such as radioimmuno assay.

Recommended Books

1. Roitt, M., (1979). Essential of Immunology, BlackWell, Oxford.
2. Benecerra, B. and Unanue, F.R. (1979). Text book of Immunology.
3. Bellanti, J.A. (1978). Immunology II, W. B. Saunders Company.
4. Fundehberg. H. Hstites, D.P., Classwel, J. B, and Wells J. O.V. (1980). Basic and Clinical Immunology, Lang Medical Los Angelos, California.
5. Hyde R., Hand Pathod, R.A., (1980). Immunology. Prentice Hall. Reston, Virginia.

ZOL-4106 HAEMATOLOGY Cr. Hrs. 2+1

Aims and Objectives

Hematology is the study of blood, blood forming tissues and organs, and blood disorders. The aims of the course are to import the knowledge and practice to the

students to specialize them in the diagnosis, treatment, and prevention of blood disorders including anemia, blood clots, bleeding disorders, and blood cancers. As blood runs through every organ and tissue in the body, hematology has an enormous ripple effect extending to all fields of medicine.

Course Contents

Introduction of blood, Constituents of blood, Function of the cellular elements of blood, Types of blood (Jaundic, Lipemic, Hemolytic, Anemic, Normal), Erythocytes, Erythopoiesis, Effect of erythropoietin, Erythroblastosis fetalis, Anemia (Nutritional anemia, Prernicious anemia, Aplastic anemia, Renal anemia, Hemorrhagic anemia, Hemolytic anemia, Sickle cell anemia, Hypochromic anemia). Types of Polycythemia (Primary polycythemia / polycythemia vera and Secondary/ Physiological polycythemia) Types of leucocytes, Types of lymphocytes, Typical human cell count, Blood cell production (Hemopoiesis), Plasma, Composition of plasma, Importance of blood group matching before blood transfusion, Factors involved in blood coagulation and clot lysis., Platelets, Formation of a platelet plug, Role of thrombin in hemostasis, Clot pathways, Anticoagulants, Types of hemophilia, Blood doping.

Practical

Study of erythrocytes. Differential leukocytic counts in normal and immunized animals.

Recommended Books

1. Hoft Brand, A.V. And petit, Je. (1981). Essential of Hematology, Blackwell, Oxford.
2. Essential Haematology. Hoffbrand, A.V. and Hoffbrand,I.E. 2002. Peltit and PAH Moss
3. Haematology. Dacie and Lewis. 2002.

ZOL-4107 BIOTECHNOLOGY-I Cr. Hrs. 2+1

Aims and Objectives

Biotechnology is a science that uses the method and process for transformation of natural raw materials into useful product by the application of living organism in the industrial process. Thus, it is the biology in service to mankind. Main aims of biotechnology are: 1) To develop industrial processes for production of antibiotics, enzymes etc, 2) To develop gene surgery and gene therapy to cure genetic disease. 3) To create immproved varieties of plants and animals through genetic engineering and plant breeding. 4) To develop techniques for tissue culture, cell culture and organ transplantation. 5) To develop bioenergy. 6) To develop biological processes of waste treatment to reduce the impact of pollution. 7) To develop biological process of plant disease control.

Course Contents

Restriction and modification system: Types, Enzyme, classification, Nomenclature, Genetics and applications. Cloning Vectors: Plasmids (Bacterial and

yeast), Viruses (Ca, MV, SV40, BPV) phages (Lambda, Mu, M13). Cosmids and phagmids. Cutting and joining of DNA: Isolation and purification of DNA, Ligation of DNA molecules, blunt ends and cohesive termini. Cloning Strategies; selection and characterization molecules, verification and amplification of desired genes, Gene Banks, PCR, RFLP, DNA sequencing techniques, DNA cloning, Southern blotting, Northern blotting, western blotting, site specific mutagenesis. Protein engineering. Applications of recombinant DNA technology with comprehensive theoretical know-how macromolecules of desired characters for transgenic.

Practical

1. Isolation of plasmids and chromosomal DNA from bacteria and yeast.
2. Screening of bacteria for plasmids by electrophoresis of total cell lysate.
3. Gel electrophoresis of plasmids DNA chromosomal DNA & RNA.
4. Comparing plasmids of different molecular weights using Molecular Weights markers.

Recommended Books

1. Rehm, J.J. 1998. Fundamentals of Biotechnology, VCH Publishers, N.Y.
2. Lee, B.H. 1996. Fundamentals of Food Biotechnology, VCH Publishers, N.Y.
3. Pirt, J.B. 1975. Microbes and Cell Cultivation, Blackwell Scientific Publishers, London.
4. Bailey, J.E. and Ollis, D. F., 1986. Biochemical Engineering Fundamentals, McGraw Hills.
5. Watson, J.D., Tooze, J. and Kurta, D.T. 1983. Recombinant DNA-A short Course, Scientific American Books, New York.
6. Old, R.W. and Primrose, S.B. 1989. Principles of gene manipulation. 4th edition, Blackwell Scientific Publishers, London.
7. Molecular cloning, 1989. A Laboratory manual, 2nd edition, Cold spring Harbor Laboratory.
8. Higgins, I.J., Best, D.J. and Jones, J. 1988. Biotechnology Principles and Applications. Blackwell Scientific Publishers, London.
9. Rehm, J.J. 1988. Biotechnology: Special Microbial Process, Vol. 6 (b), VCH Publishers, N.Y.
10. Demain, A.L. and Solomon, N.A. 1986. Manual of Industrial Microbiology.
11. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic Engineering (4th Edition). Blackwell Scientific Publications. 1994.
12. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
13. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
14. Yount L., Genetic Engineering, Gale group, 2002.
15. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002
16. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001

ZOL-4108 BIOTECHNOLOGY-II Cr. Hrs. 2+1

Aims and Objectives

Industrial biotechnology (IB) is the use of biological resources (including plant, algae, marine life, fungi and micro-organisms) for producing and processing of materials, chemicals and energy. Microbes are also used to produce high level of inductrial products through fermentation processes (e.g. brewing, bakery/industry) and enzyme engineering (as per securing vitamins, antibiotics and various biochemicals).

Course Contents

Application of biotechnology in industry; biotechnology of raw ore processing (bioleaching of sulphides, carbonates, silicates etc.) accumulation of metals by microbial cells, biopulping, biofuels, microbial enhanced oil recovery; application in agriculture, food and livestock products; biofertilization; production of cheese, probiotics, bread, single cell protein, citric acid, amino acid, acetic acid, production in drinks; microbial enzymes in industry, enzyme immobilization. Significance of Industrial Microbiology, Classification of microorganisms, fermentation principles, Culture techniques, Measurement and control of microbial processes, Introduction of probiotics. Introduction to industrial biotechnology, Biotechnology in textile, Chemical, Food, Pharmaceuticals, Agricultural industries, Industrial biocatalysts, Industrial waste, Industrial strain improvement, Screening for new metabolites, Recombinant DNA technology, Substrates for industrial fermentation, Regulation of primary and secondary metabolism, Design and development of industrial bioreactors, Problems and possibilities in fermentation scale up procedure, Bioreactors, Fermentors and controls, Bioenergy and Biofuels, Product recovery and refinement.

PRACTICAL

Screening of enzymes of industrial significance, enzyme immobilization; Production of cheese, yogurt, citric acid, amino acid and acetic acid.

Recommended Books

1. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic Engineering (4th Edition). Blackwell Scientific Publications. 1994.
2. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
3. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
4. Yount L., Genetic Engineering, Gale group, 2002.
5. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002.
6. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001.

ZOL-4109 GENERAL TOXICOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course provides knowledge and understanding about the nature and mode of action of different categories of toxicants. This will be enabled to understand the differential effects of variety of toxicants on different cellular sites. They will also learn about the procedural protocols used in toxicological studies.

Course Contents

History and general introduction to Toxicology; Types of Toxicology; Specialized areas in Toxicology; Classification of Toxic chemicals; Types of Exposure and Exposure response including exposure characteristics; Spectrum of undesirable effects; Variation in toxic responses; Dose Response relationship; Acute lethality; Descriptive animal Toxicity Testing; Sub-acute, sub-chronic and chronic toxicity; Developmental/Reproductive toxicity; Mutagenicity; Absorption, Distribution and Excretion of toxicants; Biotransformation/Disposition of toxicants; Phase-I and Phase-II Biotransformation Reactions; Mechanism of Toxicity; Delivery, from the site of exposure to the target; Absorption versus pre-systemic elimination; Distribution to and away from the target; Excretion versus re-absorption; Toxication versus Detoxication; Toxicity resulting from Delivery; Reaction of the Ultimate Toxicant with the Target molecule; Attribution of Target Molecules; Effects of Toxicant on Target Molecules; Cellular dysfunction and resultant toxicities; Toxicant-induced cellular dysregulation; Toxic alterations of Cellular Maintenance; Repair and Dysrepair.

Practical

1. Determination of LD50 values of some pesticide against any insect pest.
2. Determination of LD50 of any toxic compound in mammalian system.
3. Effect of any toxicant on body weight in mice.
4. Toxicity of some toxic compound on relative organ weight in mice.
5. Effect of toxicant on food consumption in mice.
6. Study of toxicity of any chemical on total leukocytes count.
7. Effect of toxicant on total erythrocyte count in blood of mice.
8. Effect of any toxicant on hemoglobin level in mice.
9. Study of inhibition of cholinesterase enzyme activity by organophosphate insecticides in mice.
10. Study of liver function enzyme (Alanine Aminotransferase) activity following administration of toxic compound to experimental animals.
11. Determination of blood glucose level following toxic exposure.

Recommended Books

1. Klaassen, Curtis D., (1996). Casarett and Doull's Toxicology; The Basic Science of Poisons; 5th Edition (International). McGraw-Hill, Health Professions Division, New York.
2. Timbrel, J. A. 1995. Introduction to Toxicology, 2nd Edition. Taylor and Francis Ltd. London.

ZOL-4110 HUMAN GENETICS Cr. Hrs. 2+1

Aims and Objectives

The course aims to help students learn to define basic genetics mechanisms in human inheritance to analyze inherited characteristics and diseases of human to understand genes, genomes, chromosomes and gene expression profiles with relations to phenotypic appearances, to use this knowledge for genetic research and counseling.

Course Contents

Introduction to basic concepts in genetics, brief overview of laws of inheritance, Patterns of transmission of single gene traits. Linkage and linkage maps, Genetic linkage with examples, normal chromosomes, Karyotyping. Pedigree analysis with criteria for identification of various modes of inheritance. breif description of cancer genetics, congenital malformations. Genetic defects in prenatal development; Introduction to human genome project.

Practical:

1. Pedigree analysis.
2. Karyotyping of normal and abnormal human chromosomes.
3. Screening of metabolic and other disorders.
4. Problems solving on genetic counseling.
5. Orientation with different molecular techniques including PCR, RFLP

Recommended Books

1. Strachan, T., A. P. Read, Human Molecular Genetics, 3rd edition,Garland Science/Taylor & Francis. 2003.
2. Ehrlich P.R., Human Natures: Genes, Cultures, and the Human Prospect, 1st edition, Penguin USA Paper, 2002.
3. Relethford J. H., Genetics and the Search for Modern Human Origins, Wiley-Liss 2001.
4. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc. New York.2002.

ZOL-4111 GENERAL MICROBIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course is designed to enable the students to work with microorganisms. The basic techniques of sterilization, culturing, isolation and determining different characteristics of the microorganisms are included.

Course Contents

The beginnings of Microbiology: Discovery of the microbial world; The scope of microbiology. Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual. Viruses: Bacteriophages and phages of other protests. Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses.

Morphology and fine structure of bacteria, The Cultivation of Bacteria. Reproduction and growth of bacteria, quantitative measurement of bacterial growth. Pure cultures and cultural characteristics. Eukaryotic Microorganisms: Algae: Lichens. Fungi, Protozoa. Prokaryotic diversity Bacteria, Prokaryotic Diversity: Archaea. Microbial Ecology: Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

PRACTICAL

The culture of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates. Isolation of a bacterial culture, Quantitative plating methods. The turbidimetric estimation of microbial growth.

Recommended Books

1. Pelczar Jr., Chan, E.C.S. and kreig, M.R. (1986). Microbiology, McGraw Hill, London.
2. Peltler, G.L.A Laboratory Manual of Microbiology.
3. Benson, H.J. Microbial Applications: Laboratory Manual In General Microbiology, 1994. WMC Brown Publishers, England.
4. Madigan, M.T., Martinko, J.M. and Parker, J. Brock Biology of Microorganisms, 1997. Prentice-Hall, London.

ZOL-4112 GENERAL PARASITOLOGY Cr. Hrs. 2+1

Aims and Objectives

This course aims to provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance along with their pathology, host parasite relationship and control measure. The goals of the course are to equip students with a fundamental understanding of parasitology science and competence in relevant recent parasitological techniques.

Course Contents

Principles of Parasitology. Various concepts of Parasitism. Systematics, biology, pathology and control of protozoan and helminthes parasites of medical and veterinary importance. Ecology of parasites. Host-parasite relationship. Parasitic zoonoses. Immunity and resistance.

Practical

Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance. Section cutting of the infected tissues and the study of their pathology.

Recommended Books

1. Robberts, L. Sand Janovy John Jr. (2009). Foundation of Parasitology. 8th edition. McGraw Hill, Boston

2. Chandrasoma , P. and Taylor, C.R.(1997). Concise Pathology. Prentice Hali International Inc. New Jercy USA.
3. Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London
4. Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.
5. Olsen, O. W. (1986). Animal Parasites: their life cycle and ecology. University Park Press Baltimore
6. Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
7. Robbins, S. L. Basic Pathology. W. B. Saunders Co: London, Toronto.
8. Soulsby: E. J. L. (1981). Textbook of veterinary clinical Parasitology Vol: 1 Blackwell Scientific Publication, London.
9. Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
10. Walter, J.B. and Israel, M.S. (1979). General Pathology . Charchill Living Stone Edinburgh , London and New York.

ZOL-4113 INVERTEBRATA Cr. Hrs. 2+1

Aims and Objectives

The course is designed to provide students with the concepts of structure, classification biology and evolutionary relationship of invertebrate phyla.

Course Contents

Structure, classification and biology of Protozoa, Mesozoa, Coelenterata, Cenliophora, Platyhelminthes, Nematoda, Rotifera, Annelida, Echiurida, Sipunculida, Bryozoa, Branchiopoda, Mollusca and Echinodermata.

PRACTICAL

Preparations of slides, Daphnia, Cyclops, Housefly, Mosquito, Mouth parts of cockroach and butterfly, Honey bee, Museum study of prepared slides.

Recommended Books

1. Parker and Haswell. A Text Book of Zoology (Vol .1) McMillan. London
2. Barrington, E.J.W., (1969) Invertebrates structure and function, the English Language book society, London.
3. Henger and Engelmann. Invertebrate Zoology.
4. Borradial, L.D., (1963). The Invertebrata Cambridge university press
5. Hyman, L.H. (1940). Invertebrates (Vol 1.VI). McGraw-Hill, New York.

ZOL-4114 GENERAL ENTOMOLOGY Cr. Hrs. 2+1

Aims and Objectives

The students will learn to identify the pest during damaging to the crop; Students will understand methods of population estimation of the pest and application of different control strategies.

Course Contents

Introduction, Phylum Arthropoda and its classification; external and internal morphology and physiology with particular reference to a typical insect; metamorphosis and its types; insect classification, salient characters of insect orders and families of economic importance with examples of each family.

PRACTICAL

Characters of classes of Arthropoda; collection, identification and preservation of insects; external and internal morphology of typical insects; temporary mounts of different types of appendages of insects; types of metamorphosis

Recommended Books

1. Elzinga, R. T. 2003. Fundamentals Of Entomology. Prentice Hall.
2. Gullan, P.I. & P. S. Crauston, 1994. The Insects (An Outline Of Entomology) Chapman & Hall New York.
3. Jhonson, N.F., Triplehorn, C.A. Borror And Delong's, 2004. Introduction To The Study Of Insects. Brooks Cole. 7th Edition.
4. Lohar, M.K. 1998. Introductory Entomology, Kashif Publications, Hyderabad, Pakistan.
5. Main, M.S., 1990. General Entomology (4th Ed). Oxford & IBH Publishing Co. Pvt. Ld. New Delhi.
6. Richards, O.W. And R. G. Davies, 1984. Imm's General Text-Book Of Entomology, Vol. I. And II, 10th Ed. Chapman & Hall, London, N.Y.
7. Shahid, M. 1984. Lab Mannual Of General Entomology. National Book Foundation, Paksitan.
8. Tonap, G. T., 1994. Experimental Entomology, An Aid To Laboratory And Field Studies. C.B.S. Publishers And Distributors Delhi.
9. Chapman, R.F. The Insects: Structure And Function, 2000. Blackwell Science Inc., London.
10. Krebs, C. J. Ecology: The Experimental Analysis Abundance. 5th Edition. 2000. Benjamin-Cummings Publishing Company.
11. Tembhare, DB. Modern Entomology. 2002. Himalaya Publishing House, India.

ZOL-4115 PRINCIPLES OF FISH BIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to enable students in obtaining complete understanding about freshwater as well as marine fishes in general and freshwater culturable fishes in particular. It comprises morphology, anatomy, classification and some understanding about various feeding groups found in different water bodies.

After having complete knowledge of above, students will be able to practice independently.

Course Contents

Fish Morphology: Head (Size, shape, and orientation), Scales (types, arrangements, coloration, scaleless fishes), Operculum, fins, fin rays and fin spine (Dorsal, pectoral, caudal, anal), Barbel (upper lip barbels, lower barbels). Anatomy: Skeleton (skull, backbone, spines), Brain and spinal cord, Gills (No, size, arrangements), Vital organs (heart, liver, kidney), Viscera and mesenteries. Swim bladder, stomach, spleen, pancreas, intestine, glands. Systematic: Identification of fishes up to; families, Order, Genus and Species, Feeding groups of fishes, herbivore, Plankton eater, Larvivore, Carnivore, Voracious. Ecology of fishes: Freshwater, Brackish water, Marine.

PRACTICAL

1. Collection, Preservation and identification of freshwater fish species.
2. Study of different organs of various fish species
3. Study and survey of various fish collection present in museum like Natural History Museum at Islamabad, G.C. Lahore & at P.U. Lahore.

Recommended Books

1. Kestin Farmed Fish Quality (2001).
2. Woo. Fish diseases and Disorder: *Protozoan and Metazoan infections* (1995)
3. Brenabe Aquaculture Vol. I&II (1992) Fishing News Books Ltd. England
4. Maseke C. Aquaculture, I&II (1992) Pergamon Press, Oxford.
5. Huet M. Text Book of Fish Culture: *Breeding and cultivation* Fishing News Book Ltd. England.
6. Kestin, S. C. and Warris, P.D. (Edition). Kestin Farmed Fish Quality, 2002, Blackwell Science, Oxford, UK.

ZOL-4116 FISHRIES AND AQUACULTURE Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide knowledge about differnt requirments for the culture of different cultivable aquatic species. The subject provides Practical information to obtain better growth by following physiological aspects during extensive or semi-intensive culture. It also emphasizes thoroughly in breeding and diseases of most culturable freshwater fishes and prawns.

Course Contents

Basic principles of Aquaculture (fish and prawn). Natural food and feeding. Growth and breeding of the important culturable prawns and fishes. Diseases and their control.

PRACTICAL

Study of the gut contents of important fishes. Study of the major parasites of fish. Study of early developmental stages of fishes. Methods of induced spawning.

Recommended Books

1. Auet, M. (1972). Textbook of Fish Culture, Breeding and Cultivation of Fish.
2. Various publications of the Directorate of Fisheries on fish-farming etc.
3. Brenabe, G. AQUACULTURE, Vol. I. 1992 Blackwell Publishing, Oxford. UK.
4. Maseke C. FISH AQUACULTURE. 1987. Pergamon Press, Oxford. UK.

ZOL-4117 LIMNOLOGY-A Cr. Hrs. 2+1

Aims and Objectives

To provide information about inland waters, biological productivity and to minimize the pollution of inland water for better aquaculture production. The student will be able to learn about physical and chemical properties of water in order to increase biological production.

Course Contents

Definition, Importance, Inland waters, Sources of bottom materials, Physical features of water, temperature, light, currents, density and water turbidity. Chemical features of water dissolved gasses, dissolved solids, pH, Electrolytes alkalinity, hardness, salinity, brief description of nitrogen and phosphorous cycles.

PRACTICAL

Survey of major water bodies in Azad Kashmir & Pakistan (lotic and lentic waters). Morphometric analysis of rain water, stream water, lake water, pond water and ground water. Preliminary general tests, odour, colour, dissolved gases, dissolved solids, suspended solids, pH, alkalinity, salinity, hardness, micronutrients.

Recommended Books

1. Goldman, C.R. and Horne, A.J. 1983. Limnology. McGraw Hill, International Book Company, Japan.
2. Welch, P.S. 1968. Limnology, 4th Edition, McGraw Hill book. Inc. New York.
3. Allen S. E. 1990. Chemical Analysis of Ecological Materials, Scientific Publishers, London.
4. Robert G. Wetzel. 1983. 2nd Edition. Limnology. Saunder Publishers, New York.
5. Gerald A. Cole. 1983. 3rd Edition. A Text Book of Limnology. Waveland Press Inc. USA.

ZOL-4118 PRINCIPLES OF HERPETOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide knowledge about the classification, population and distribution of amphibia and reptiles with refernece to their ecological adoptations and interactions.

Course Contents

Classification of amphibians and reptiles. Evolution, geographical distribution, population biology of reptiles and amphibians. Biology, including anatomical, physiological adaptations to their environment, reproduction, foods/feeds, communication (vocal, chemical, behavioural). Mechanism of hibernation in herpeto-fauna (effect of climatic factors). Poisonous species. Sensory mechanisms, predator-prey relationships, chemistry and physiological actions of venoms and patho-physiology and treatment of snake bite.

Practical

1. Visit of PMNH for study of preserved specimens of herpeto-fauna in relation to their taxonomy and ecosystem.
2. Field visits of different habitats for direct/indirect observations of amphibians and reptiles with respect to their ecologies and weather conditions.
3. Visit to Zoos and wildlife parks.

Recommended Books

1. Daniel, J.C. 1992. The Book of Indian Reptiles . Bombay Natural History Society, India.
2. Girard, C. 1978. Herpetology. Arno Press.
3. Pough, F. H. 2001. Herpetology. Prentice Hall.
4. Zug, G. R. 1993. Herpetology: An introductory biology of Amphibian and Reptiles. Academic Press.
5. Khan, M.S. 2006. Amphibians and reptiles of Pakistan. Krieger Publishing Company, Florida, USA. 311 pp.

ZOL-4119 BIODIVERSITY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide basic knowledge to students about the basic concepts of biological diversity, threats to biodiversity and its management. Also to provide knowledge about the threatened species of wild animals and their management principles and efforts being made at global and national level.

Course Contents

Definition, Types; Levels; Status of Biodiversity; Biodiversity resources of Pakistan including AJ&K. Importance of Biodiversity. Major threats and causes of loss of biodiversity, Conservation of biodiversity. In-situ & ex-situ conservation of biodiversity, Protected areas concept. Pakistan and IUCN PAs categories, Ramsar sites, Biodiversity Action Plan for Pakistan. biotechnological intervention in biodiversity conservation, International laws/conventions (CBD, CMS, CITES, Ramsar, etc.) regarding biodiversity conservation and their implementation in Pakistan.

Practical

1. Procedures for studying biodiversity, species richness, Simpson Index, Shannon and Weiner Function.

2. Bird's population Census Techniques.
3. Mammal's population Census Techniques.

Recommended Books

1. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing & Co. London, UK.
2. K. V. Krishnamurthy, 2003. Text Book of Biodiversity, Science Publisher USA
3. B.N. Pandey, A.P. Sharma, P.N. Pandey, P.K. Katiha and K. Jaiswal (editors), 2012. Biodiversity: Issues Threats and Conservation: Narendra Publishing House.
4. Kumar & Asija, 2000. Biodiversity, Principles and Conservation.
5. Mary Jenking and Ann Boyce, 1987. The Diversity of Life.
6. R. Rehmani and Salim Ali: Birds Censing Techniques.
7. Roberts, T. J. The Birds of Pakistan, (Vol. II), 1992. Oxford University Press.
8. Roberts, T. J. The Mammals of Pakistan, 1997. Oxford University Press.
9. Mirza, Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
10. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley & Sons, Inc.
11. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
12. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition).McGraw Hill, New York.
13. Ali, S.S. Paleontology, Zoogeography & Wild-Life Management. 1999. Nasim Book Deptt. Hyderabad, India.
14. UNEP. 2005. Selected texts of legal instruments in international environmental law. United Nations Environment Program. Nairobi. Kenya.734.

ZOL-4120 HISTOLOGY Cr. Hrs. 2+1

Aims and Objectives

The fundamental aim of histology is to determine how tissues are organized at all structural levels, from cells and intercellular substances to organs.

Course Contents

Brief introduction to cells and tissues, study of epithelial tissues, connective tissues, blood cells, lymphatic tissues and the immune system, bone and cartilage, joints, muscles. Anatomy of heart, lungs, liver, kidney, spleen, digestive tract, brain, skin and endocrine glands and reproductive tract with histopathological aspacts.

Practical

Preparation and study of stained slides of different tissues of animals

Recommended Books

1. Eroschenko, Victor, P. (2008). Difioe's Atlas of Histology with Functional Correlations 11th Edition. Wolters Kluwer health (India) Pvt. Ltd. New Delhi.
2. Luiz Carlos Junqueira and Jose Carneiro (2005). Basic Histology Text and Atlas 11th Edition. McGraw Hill Medical Publishing Division New York.
3. Mills, Stacey, E. (2007). Histology for Pathologists 3rd Edition. Lippincott Williams and Wilkins a Wolters Kluwe Business Philadelphia.
4. Ham, Arthur W., Cormack, David, H (1987). Ham's Histology 9th Edition. J.B. Lippincott Company, Phlladelphla. London.
5. Arthur Smith & John Bruton (1977). A Colour atlas of Histlogical Staining Techniques. Wolfe Medical Publication Ltd. London WC2.
6. Copenhaver, Wilred M., & Kelly, Douglas E., & Wood, Richard, L (1978). The Williams and Wilkins Company/Baltimore Tokyo.
7. M. Ahsan Karim, & Khalid M. Khan, (1986). A Guide Histology Practical. Feroz Sons Lahore Pakistan.
8. Ham, Arthur W., (1969). Histology 6th Edition. J.B. Lippincott Company Philadelphia Toronto.

ZOL-4121 BIOLOGICAL TECHNIQUES Cr. Hrs. 2+1

Aims and Objectives

1. To make aware of the basic philosophy of science, its history, concepts and scope
2. To develop proper scientific mind, culture and work habits
3. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
4. Basic understanding on principle and uses of the following:

Course Contents (theory and Practical)

Microscopy: Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopy, Bright field (Compound Microscope), Scanning microscopy, Eyepiece micrometers, Camera Lucida Phase Contrast Dark field Interference microscope, Electron microscope. **Micrometery and Morphometry**: Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter). **Standard system for weight, length, volume :** Calculations and related conversions of each:- Metric system- length; surface; weight - Square measures- Cubic measures (volumetric)- Circular or angular measure- Concentrations- percent volume; ppt; ppm - Chemical molarity, normality - Temperature- Celsius, centigrade, Fahrenheit. Preparation of stock solutions of various strengths. **Specimen preparation for optical microscopy**: **Microtomy:** Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections. **Extraction techniques:** Centrifugation, Ultra centrifugation, cell fractionation, filtration, Distillation, Use of Soxhalet and Rotary evaporator for extraction. **Separation Techniques:** Chromatography: Principle, applications, types, thin layer, paper, column, gas, ion exchange chromatography. Electrophoresis: Principle, applications, types. **Spectrophotometery:** Principle, applications, types, visible spectrum, UV spectrum, atomic absorption. **Basic principles of Sampling and Preservation:** Sampling soil

organisms, Invertebrates, Aquatic animals, Mammals, Estimation of population size, Preservation of dry and wet specimens. Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field.

Recommended Books

1. Dean, J. R. Extraction methods for environmental analysis. 1999. John Wiley And Sons Ltd. UK.
2. Curos, M. Environmental sampling and analysis: Lab Manual. 1997. CRC Press Lic. USA. 38
3. Curos, M. Environmental sampling and analysis: For Technician. 1997. CRC Press LLC. USA.
4. Cheesbrough, M. District laboratory practice in tropical countries. Part i. 1998. University Press Cambridge, UK.
5. Cheesbrough, M. District laboratory practice in tropical countries. Part ii. 1998. University Press Cambridge, UK.
6. Slingsby, D. and Cock, C. Practical ecology. 1986. Mcmillan Education Ltd. London.

ZOL-4122 RESEARCH METHODOLOGY Cr. Hrs. 2+1

Aims and Objectives

The main objectives of this paper are to introduce student to the basics of research and research design in biology and to prepare them to develop and design their own research works, formulate their research manuscripts etc.

Course Contents

Introduction: Meaning of research, objectives and significance of research, research processes, criteria for good research, problems encountered by researchers in Pakistan. **Defining research problem:** Selecting research problem, techniques involved in defining a problem. Developing hypothesis. **Review of literature:** Different forms and sources of acceptable data and techniques of acquiring required literature. **Research and sampling design:** Need for research design, characteristics of a good research design, basic principles of experimental designs, Steps in sampling designs, different types of sampling designs, developing a research proposal/ plan. **Data collection:** types of data, methods of data collection, processing and analysis of data, **Writing of Research Thesis/Report and Research Paper:** (composition, arrangement and formatting); Publication of research work, finding of suitable journal, formatting and submitting of manuscript, Ethical, legal, social and scientific issues in Biological Research. Plagiarism. **Introduction to scientific research projects/funding:** Finding financial support and industry partnership. A brief idea about the funding agencies such as HEC, PSF, EU, USAID. etc.

Practical

Designing and developing case studies. Practice of Review of literature from different sources. Practice of writing scientific papers/ projects.

Recommended Books

1. Michael P. Marder, 2011. Research Methods for Science. Cambridge University Press
2. Thomas E. Ogden, Israel A. Goldberg, 2002. Academic Press USA
3. C.R.Kottari. 1990. Research Methodology: Methods and Techniques (2nd Ed.) Ram Printograph. Delhi
4. Robert, A. Day. 1989. How to write and publish a scientific research paper. 3rd Edition.
5. Holmann, H.H. 1962. Biological research method. Olvyer and Boyd Ltd.

LIST AND COURSE CONTENTS OF ELECTIVE/OPTIONAL/SPECIAL COURSES FOR BS-4 YEARS PROGRAM IN ZOOLOGY 8TH SEMESTER

Course Code	Course Title	Lec. Hrs	Lab. Hrs.	Credit Hrs.
ZOL-4201	Physiological Systems and Adaptations	2	1	3
ZOL-4202	Molecular Physiology	2	1	3
ZOL-4203	Endocrinology	2	1	3
ZOL-4204	Animal Behaviour	2	1	3
ZOL-4205	Economic Zoology	2	1	3
ZOL-4206	Bioremediation & Environmental Biotechnology	2	1	3
ZOL-4207	Biochemistry – II	2	1	3
ZOL-4208	Molecular Biology	2	1	3
ZOL-4209	Medical Microbiology	2	1	3
ZOL-4210	Applied Microbiology	2	1	3
ZOL-4211	Medical Parasitology	2	1	3
ZOL-4212	Helminthology	2	1	3
ZOL-4213	Vector Biology	2	1	3

ZOL-4214	Animal Pests and Disease Producing Organisms	2	1	3
ZOL-4215	Fish Physiology	2	1	3
ZOL-4216	Ichthyology (Fish Morphology)	2	1	3
ZOL-4217	Limnology-B	2	1	3
ZOL-4218	Vertebrata	2	1	3
ZOL-4219	Ornithology	2	1	3
ZOL-4220	Mammalogy	2	1	3
ZOL-4221	Wildlife	2	1	3
ZOL-4222	Environmental Issues	2	1	3
ZOL-4223	Comprehensive Oral Examination	S/U Basis		
ZOL-4224	Research Project	0	0	6

ZOL-4201 PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS Cr. Hrs. 2+1

Aims and Objectives

The course aims to understand the basic physiological mechanisms relating to different body organs and systems and their relationship with the surrounding environment.

Course Contents

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; cerebral, fetal. **Respiratory System:** Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbon dioxide; Regulation of ventilation; Respiratory responses in extreme conditions. **Renal System:** Elements of renal function; tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostasis; Role of kidney in acid-base balance. **Gastrointestinal System:** Gastrointestinal secretions and their control: salivary, gastric, pancreatic and hepatic; Digestion and absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments. **Osmoregulation:** Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aqueous and terrestrial environments. **Environmental Challenges:** Temperature and animal energetics; Temperature relation of ectotherms, Heterotherms and endotherms;

Dormancy: Special metabolic state; body rhythms and energetic; Energy, environment and evolution.

PRACTICAL

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of different factors; Demonstration of respiratory volume and pulmonary function tests. Experiments on digestion of nutrients by enzymes and effects of factors; study of exocrine secretion in stomach and pancreas. Experiments on kidney regulation of osmolarity; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Recommended Books

1. 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
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 8th ed. Lippincott, Williams and Wilkins, Philadephia.
3. Berne, R.M. and Loevy, M.N., 2000. Principles of Physiology, 3rd edition. St. Lious, Mosby.
4. Guyton, A.C. and Hall, J.E. 2000. Textbook of Medical Physiology, 10th Edition. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environments, 5th edition. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D. 2002. Experiments in Physiology, 8th Edition. Prentice Hall, London.

ZOL-4202 MOLECULAR PHYSIOLOGY Cr. Hrs. 2+1

Aims and objectives

1. To understand physiological mechanism at molecular level.
2. To correlate molecular mechanisms at organs and organism level.

Course Contents

Overview of resting membrane potential, action potential and synaptic transmission; Structure and mechanisms of ion channels; Biosynthesis of neurotransmitters; Neurotranmitters actions at synaptic receptors. Neurosecretions and neurotransmitters in higher nervous system activity. Molecular mechanisms in transduction of sensory stimuli into impulse; photochemistry and transduction of photoreceptor; Colour vision. Overview of endocrine glands, their hormones and roles; Chemistry and biosynthesis of hormones of adenohypophysis, thyroid, parathyroid, endocrine pancreas, adrenal medulla and steriodogenic tissues;

Metabolism of thyroid and steriodogenic tissues; structure of hormone receptors; Mechanisms of action of a protein/peptide, a steroid and thyroid hormone; Hormonal regulation of metabolism; Molecular basis of muscular contraction; Molecular interaction at neuromuscular level; Molecular structure of cilia and flagella and mechanisms in movements. Exchange of respiratory gases; Chemical regulation of respiration. Nature and formation of various nitrogenous waste products; Glomerular filtration, reabsorption and secretion mechanisms; Concentration of urine. Regulation of digestive secretions; Digestion and absorption of nutrients. Molecular mechanisms in adaptation to temperature extremes.

PRACTICAL

Study of post-synaptic receptor mechanisms in neuromuscular preparation of frogs; Experiments to study the molecular responses to hormones. Study of hormones receptors in different hormonal circulation levels; Ultra-structure study of muscle structure for muscle contraction. Effect of chemicals and drugs on cardiac activity of prepared frogs; study of drugs on reflexes and local circulation models. Respiratory function and oxygen consumption in acidosis and alkalosis in mouse. Study of nature of nitrogenous wastes of animals inhabiting different environment. Urine analysis in different physiological states. Absorption of glucose in inverted intestinal sac, effect of drugs on intestinal movements. Muscular responses to pyrexia.

Recommended Books

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company,
2. Bullock, J., Boyle J. and Wang, M.B., 2001. Physiology 8th edition. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd edition. St. Lious, Mos by.
4. Guyton, A.C. and Hall, J.E., 2000. Textbook of Medical Physiology, 10th Edition. W.B. Saunders Company, Philadelphia.
5. Withers, P. C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environments, 5th edition. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2002. Experiments in Physiology, 8th Edition. Prentice Hall, London.

ZOL-4203 ENDOCRINOLOGY Cr. Hrs. 2+1

Aims and Objectives

1. General concepts and principles of chemical coordination.
2. The details of the endocrine mechanisms in relation to various functions such as reproduction and lactation.
3. Recent trends of endocrinology in relation to diversified function.

Course Contents

Introduction Endocrinology, Vertebrate Endocrine System. Mechanism of Hormone Action Endocrine Methodologies, Pituitary Hormones, the Endocrine Hypothalamus, Neurohypophysial Hormones, Opiomelanocortins, Hormonal control of Calcium Homeostasis, GIT hormones, Pancreatic hormones and metabolic regulation, Growth hormones, Thyroid hormones, Catechoalmines and sympathoadrenergic system, Adrenal steroid hormones, Endocrinology of sex differentiation and development, Hormones of male reproductive physiology, Hormones of female reproductive physiology, Endocrinology of Pregnancy, Parturition and Lactation, Endocrinology of Pineal Gland. Pathophsiology of hormones.

Praticals

Gross and histological structure of endocrine glands. Techniques of ansthesia and surgery. Studies in physiological effects of hormones.

Recommended Books

1. Greenspan, F.S. and Strewler, G.J. (2002). Basic and clinical endocrinology. 5th Edition. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R. (1998). Williams Textbook of Endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
3. L.J., Jameson, J.L. et al. (2001). Endocrinology. DeGroot Vol.I, II, III, 4th ed. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., (2000). Textbook of Endocrine Physiology. 4th Edition. Oxford University Press, Oxford.
5. Neal, J.M., (2000). Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.
6. Turner, C.D. and Bagnara, J.T. (1976). General Endocrinology, W.B, Saunder London.
7. Barrington, E.J.W. (1963). An introduction to General and Comperative Endocrinology, Calrendom Press.
8. Bently, P.I. (1982). Comparative Vertebrate Endocrinology, Cambridge University Press Cambridge.
9. Wilson, J.D. and Foster D.W. (1985). Text Book of Endocrinology. W.B Saundres, Philadeliphia.

ZOL-4204 ANIMAL BEHAVIOUR Cr. Hrs. 2+1

Aims and Objectives

To teach students:

1. The concept of physiological mechanism.
2. Functional aspects in animal life
3. The designs of mechanisms in nervous and hormonal coordination, muscle and movements, respiratory gas exchange, excretion and osmoregulation, nutrition and thermal regulation.

4. To correlate these mechanisms at biochemical, molecular and cellular levels to the functions at organ system and organism level.
5. Physiological mechanisms in manifestation of behaviour.

Course Contents

Introduction: History of animal behaviour. Approaches and methods. Mechanisms of behaviour: The nervous system and behaviour. Hormones and behaviour Immunology and behaviour. Biological rhythms. Development of behaviour. Learning behaviour. Communication. Finding Food and shelter: Migration, Orientation and navigation. Habitat selection. Foraging behaviour. Social Organization and Mating systems: Conflict. Sexual reproduction and parental care. Mating systems and parental Care. Social systems.

PRACTICAL

Experiments on reflexes, latency, after-discharge, summation, warm up, fatigue, inhibition and feedback. Experiments on habituation, conditioned reflex type I and trial and error learning. Experiments showing hormonal involvement in behavioural responses. Study of social integration in social insects. Study of hibernation and biological rhythms.

Recommended Books

1. Drickamer, L. C., Vessey, S. H. and Jacob, E. 2002. Animal behaviour: Mechanism, Ecology Evolution. 5th Edition.
2. Manning, A. and Dawkins, M. S. 1997. An introduction to animal behaviour, 8th edition. Cambridge University Press, Cambridge.
3. Tonap, G. T. 1998. Experimental Entomology an Aid to Laboratory and Field Studies. C. B. S. Publishers Delhi.

ZOL-4205 ECONOMIC ZOOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course provides the basic knowledge about the economic importance of various species of animal kingdom. It provides knowledge about the delitarious effects of different species (e.g., parasites) on human society and also provides the basic knowledge on the positive aspects of different animal species.

Course Contents

Parasitic protozoa and diseases. Phytoparasitic, Nematodes and their control. Helminthes Parasites of man and other domestic animals and their control. Mites and ticks and their control. Households insects. Insects of cash crops. Apiculture, Lac-culture, Sericulture and fisheries in Pakistan. Aquaculture value added by products of fishing industry. Poultry economic importance of mammals. Genetic improvement of animal. Leather industry. Wool industry. Pharmaceuticals from animals. Bioactive substances from animals, Rats and their control. Resource survey and management

Recommended Books

1. Shukla, G.S. Economic Zoology.

2. Vishwaprem, K. K. C. Economic Zoology.
3. Jawaid Ahsan, Subhas Prasad Sinha. A Hand Book On Economic Zoology.
4. Shukla & Upadhyaya. 2009. Economic Zoology 4th ed. Rastogi Publications.
5. Mathur S., 2009. Economic Zoology Biostatistics and Animal Behaviour. Rajpal and Sons Publishing.

ZOL-4206 BIOREMEDIATION & ENVIRONMENTAL BIOTECHNOLOGY
Cr. Hrs. 2+1

Aims and Objectives

Biodegradation of various pollutants and also acts as the microbial metabolism to remove pollutants. The purpose of environmental and bioremediation is used to study harmul substances which are contaminating the environment and discovering and inventing such processes which can be beneficial for the environment.

Course Contents

Concept of bioremediation; Bioremediation of heavy metals, xenobiotic compounds and hazardous wastes; techniques used in bioremediation, bioremediation through consortia of microbes and invertebrates; renewable and non-renewable resources; bioleaching and biomining (low grade and sulfide containing ores processing); domestic solid waste and management. Waste water, sludge and sewage management; biological methods of wastes treatment; sample collection and preservation; bioremediation of crude and petroleum oils. Role of yeast in bioremediation. Biological fuel generation; Bioremediations of industrial effluents.

Practical

Bioremediation of heavy metals through invertebrates, consortia of microorganism, mycoremediation.

Recommended Books

1. Environmental Science (Earth as a living planet). 2000. 1st ed. Botkin, D. and Keller, E. John Wiley and Sons Inc. New York, USA.
2. Practical Environmental bioremediation the field guide, 1977. R. Barry. King, Gilbert M. Long John K. Sheldon, Lewis Publishers.
3. General Microbiology, 1995. Schlegel, H.G., Cambridge University Press.
4. Biotechnology, 1996. Smith, J.F., Cambridge University Press.
5. Environmental Biotechnology Principles and Applications, 2000.Pruce, R. Hmana, Parry McCarty, McGraw Hill.
6. Biodegradation and Remediation, 1999. Martin Alexander Academic Press Inc.

ZOL-4207 BIOCHEMISTRY-II Cr. Hrs. 2+1

Aims and Objectives

The course will provide in depth knowledge about the biochemical processes and organic compounds of life including macromolecules. The dynamism of the life

proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It will deal with the inter-conversion performed by various tools called as enzymes. Thus, in this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Course Contents

Constituents of living organisms, Prebiotic molecular evolution, Origin of biomolecules and living cells. Properties of aqueous solutions, Acid, Base, buffers and pH. Thermodynamics principles, Laws of thermodynamics, Free energy chemical equilibria. Characteristics and biological functions of amino acids, proteins, carbohydrates and lipids. DNA (double helix, DNA melting eukaryotic chromosomes), Synthesis of oligonucleotides RNA (messenger, transfer and ribosomal). Characteristics of enzymes activity. Metabolic pathways: Glycolysis; Citric acid cycle; Electron transport chain and Oxidative phosphorylation; Other pathways of carbohydrate metabolism. Photosynthesis. Lipid digestion, absorption and transport, Fatty acid oxidation and synthesis of ketone bodies and cholesterol metabolism. Biosynthesis of amino acids, amino acid deamination, decarboxylation, transamination, Urea Cycle. Nitrogen fixation. Nucleotide synthesis and degradation. Interrelation and regulation of metabolic pathways and energy metabolism.

PRACTICAL

1. Qualitative tests of amino acids.
2. Qualitative estimation of proteins by UV and Lowry's method. Extraction and slating out of proteins. Gel filtration, Ion exchange chromatography and polyacrylamide gel electrophoresis of proteins. Determination of molecular size of proteins by SDS –PAGE.
3. Qualitative test of different lipids. Fractionation of brain lipids and their analysis by thin layer chromatography.
4. Qualitative test for carbohydrates. Glycogen isolation and hydrolysis. Determination of reducing sugars. Enzymatic determination of glucose. Paper chromatography of sugars.
5. Isolation of lactate dehydrogenase from heart muscles of rabbit and analysis of isoenzymes of PAGE. Isolation of peroxide from turnip and study of its kinetics.

Recommended Books

1. Voet, D and Voet, J.G. (1990). Biochemistry, John Wiley & Sons
2. Zubay, G.l. (1983). Biochemistry, McMillan Publishing Co.
3. Rawn, J.D (1989). Biochemistry, Neil Patterson Publishers, North Carolina.
4. Conn and Stumpf, (1989). Outlines of Biochemistry, John Wiley & Sons.
5. Stryer, L. (1988). Biochemistry, W. H. Freeman & Co., New York.
6. Davlin, J. (1992). Textbook of Biochemistry with Clinical Correlation, John Wiley & Sons.

ZOL-4208 MOLECULAR BIOLOGY Cr. Hrs. 2+1

Aims and objectives

Objectives of the course are to impart knowledge about the macromolecules in animal cell and their complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms.

Course Contents

Molecular Biology of DNA, RNA, Protein, Mechanism of DNA replication and DNA repair including involved enzymes. Prokaryotic and eukaryotic Transcription, post transcriptionmodifications in eukaryotes. Genetic code, Mechanism of Translation and eukaryotic post-translation modifications, Gene expression in prokaryotes and eukaryotes. Molecular biology of DNA and RNA viruses..

Practical

Quantitative estimation of various macromolecules. Demonstration of properties of macromolecules. Methods of bacterial culture.

Recommended Books

1. Kornberg, A. (1980). DNA Replication, W.H. Freeman, San Francisco.
2. Kornberg, A. (1982). Supplement to DNA Replication, W.H. Freeman, San Francisco.
3. Old, R.W. and Primrose, S.B. (1981). Principles of Gene Manipulation, Blackwell, Oxford.
4. Watson, J.D., Hpkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. (1990). Molecular Biology of the Gene, Benjamin, California.
5. DuPraw, Advances in Cell and Molecular Biology, Academic Press.
6. Bukhari, A.I., Shapiro, J.A., and Adhya, S.L. (1977). DNA Insertion Elements, Plasmids and Episomes, Cold Spring Harbour Laboratories.
7. Stent, G.S., (1971). Molecular Genetics, Freeman, San Francisco.
8. Glass R.E., (1982). Gene Function: E. coli and its Heritable Elements, Croom Helm, London.
9. Adams, R.L.P., Knowler, J.T. and Leaer, D.P. (1986). The Biochemistry of the Nucleic Acids, Chapman and Hall.
10. Davis, R.W., Botstein, D. and Roth, J.R. (1980). Advanced Bacterial Genetics, Cold Spring Harbor Lab., N.Y.
11. Freifelder, D. (1983). Molecular Biology, A Comprehensive Introduction to Prokaryotes and Eukaryotes. Science Books International, Boston.

ZOL-4209 MEDICAL MICROBIOLOGY Cr. Hrs. 2+1

Aims and Objectives

Aims of this course are to let the students know about the science of microbiology, to work with microorganisms, their pathogenecity, and various diseases and problems caused by microorganisms. The course may also initiate their interest in agricultural, industrial and/or environmental microbiology. The course will enable the students to identify specific areas in practical life where the science of

microbiology is being applied. Thus they can seek different job in various organizations such as clinical, industrial and environmental microbiology sections.

Course Contents

Microbiology and Medicine, antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of the infections in the community. Immunological principles, antigen, antibodies and antigen-antibody reactions. Bacterial pathogens and associated diseases. *Staphylococcu*s, skin and wound infections. *Streptococcus*, sore throat, scarlet fever, glomeruonephritis. *Pneumococcus*, respiratory infections*. Corynebacterium*. *Diphtheriae Mycobacterium tuberculosis*: Pulmonary and other tuberculosis infections. *Actinomyces. Neisseria meningitis*, *Gonorrhea*, *Salmonella, Shigella, Escherichia coli, Klebsiella proteus, Providenica, Bacillus anthracis. Clostridium tetani*. Pox viruses, Herpes viruses. Herpes simplex. Cytomegalovirus infections. Adenoviruses. Influenza viruses. Hepatitis viruses. Arbovirsus, Rickettsia, Pahtogenic. Fungi and Protozoa. Bird flu, Measles, Dengue.

Practical

Basic techniques.(Staining of microorganisms: Simple stains, positive staining; negative staining. Demonstration of special structures by stains: Spore stain, Flagella stain. Differential stains: Gram stain, Metachromatic Granule stain, Acid fast stain. Culturing of microorganisms: Isolation of a bacterial culture. Quantitative plating methods) Widal test. Laboratory diagnosis and control of infections: Streptococcus. Corynebacterium, Listeria, Mycobacterium. The Entero bacteriaceae: Salmonella. *Escherichia, Klebsiella* and *Clostridium*. Blood tests: TLC, DLC, RBC.

Recommended Books

1. Kenneth Ryan, C. George Ray, Nafees Ahmad, W. Lawrence Drew, James Plorde. (2010). Sherris Medical Microbiology, Fifth Edition. McGraw Hill Publishers, Washington DC
2. Patrick R. Murry, Ken S. Rosenthal, Michael A. Pfaller: Medical Microbiology**,** 5th edition, Philadelphia: Elsevier/Mosby, 2005.
3. P.K. Murray, Ph.D., K.S. Rosenthal, Ph.D., G.S. Kobayashi, Ph.D., and M.A. Pfaller, MD, 4th Edition, Mosby, Inc. 2002. ISBN #0323012132
4. Sherris medical microbiology: an introduction to infectious diseases C. George Ray, Editor; McGraw-Hill/Appleton and Lange 5th edition, McGraw-Hill/Appleton & Lange, 2003. ISBN#0838585299
5. Microbial Applications (Complete Version) Laboratory Manual In General Microbiology, 1994. Benson, H.J. WMC Brown Publishers, England.
6. Microbiology, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.
7. Brock Biology of Microorganisms, 1997. Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall, London.
8. Cruickshank, R, Duguid, J.P., Hermion, B.P. and Swain, R.H.A., (2003). Medical Microbiology. Churchill Livingstone, N.Y.

9. The Microbial World, 1986. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. Prentice Hall, London.
10. Foundations in Microbiology. (1998). Talaro & Talaro. WCB Publishers, New York.
11. Microbiology: A Human Perspective, 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher Education.
12. Microbiology Principles and Explorations, 2001. Jacquelyn, G.G. Wiley John & Sons Inc.

ZOL-4210 APPLIED MICROBIOLOGY Cr. Hrs. 2+1

Aims and Objectives

Aims of this course is to let the students know about the applications of the science of microbiology in the different fields of life. The course may initiate their interest in agricultural, industrial and/or environmental microbiology.

Course Contents

Control of microorganisms: Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapeutic agents. Microorganisms and diseases: Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact diseases. Infectious diseases of animals. Environmental microbiology: Fundamentals of microbial ecology. Microbiology of air. Aquatic microbiology. Soil microbiology. Microbiology of domestic water and sewage. Microbiology of food, milk and milk products. Industrial Microbiology: Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

PRACTICAL

1. Bacteriological examination of water. Isolation and Identification of enteric pathogen. Selective medium for the isolation of pathogenic Staphylococci. The coagulase test for pathogenic *Staphylococcus*, Sucrose plates. *Streptococcus silvarius*. Normal throat flora and reactions on Blood Agar. Slide Agglutination test.
2. Inhibition and destruction of microorganisms by physical agents (temperature, desiccation, light). Action of disinfectants on bacteria. Bacteriostatic action of certain dyes and drugs.

Recommended Books

1. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. Microbiology: A Human Perspective, 2001. McGraw Hill Higher Education.
2. Jacquelyn, G.G. Microbiology Principles and Explorations, 2001. John Wiley & Sone Inc.
3. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., Microbiology, 1986. McGraw Hill, London.

4. Benson, H.J. Microbial Applications: LAB Manual In General Microbiology, 1998. WMC Brown Publishers, UK.

ZOL-4211 MEDICAL PARASITOLOGY Cr. Hrs. 2+1

Course Contents

Systematic, biology, pathology, host parasite relationships. Study of parasites belonging to phyla: Protozoa Platyhelminthes, Nematoda, Annelida and Arthropoda. Study of parasitic diseases in animals and humans and their control.

PRACTICAL:

Methods of collection, preservation and transportation of parasitic material. Isolation of these parasites from different sources and their identification. Identification of insects of medical and veterinary importance.

Recommended Books

1. Noble and Noble, 1982. Parasitology. The Biology of Animal Parasites. 5th edition. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical Parasitology. 3rd edition. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol. I. University Press Cambridge.
4. Smith, J.D., 1994. Introduction to Animal Parsitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J.Jr., 2001. Foundations of Parasitology. 5th Edition. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000. Veterinary Parasitlogy Longman Scientific and Technical publications, Longman Group, U.K.

ZOL-4212 HELMINTHOLOGY Cr. Hrs. 2+1

Aims and Objectives

This course aims at introducing the common parasites of man and livestock to students with a view to understand their lifecycles, morphology, pathology, diagnosis, epidemiology and control.

Course Contents

Introduction to the phylum: Platyhelminthes, Trematoda, Aspidohothria, Trematoda, Form function, Life cycle and classification of digeneans, Digenians, Strigeiformes, *Schistosoma haematobium, S. japonicum, S. mansoni* (schistosomiasis); Digenians echinostomiformes; *Fasciola hepatica, F gigantica, Paramphistomum cervi.* Nematodes, Taenia, Cestodes.

Recommended Books

1. Chandler, C. and Read, C.P. 1961. Wiley Toppan. Introduction to Parasitology.

2. Crewe, W.H.K. 1977. A Guide to Human Parasitology, Lowis and Company Ltd.
3. Noble and Noble, 1982. Parasitology. The Biology of Animal Parasites, Lea and Febiger.
4. Beck, J. W. and Davies, J.E. 1981. Medical Parasitology Mosby Company, Toronto, London.
5. Cheesbrough, M. Medical 1987. Laboratory Manual For Tropical Medicine, Vol. I. University Press Cambridge.
6. Sood, R. 1998. Parasitology: Protozoology And Helminthology,
7. Smith, J.D. 1998. Introduction to Animal Parasitology, University Cambridge Press.
8. Roberts, L.S. and Janovy, J. Jr. 2000. Foundations of Parasitology, Brown Publishers, Chicago, London.

ZOL-4213 VECTOR BIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course aims to provide students with a broad understanding of the key aspects of insect vector behaviour, vector ecology and vector-parasite interactions relevant to the epidemiology and control of vector-borne diseases.

Course Contents

Detailed studies of systematic, Biology and ecology of some vectors of medical importance (order Diptera) Mosquitoes: Anopheles mosquitoes, culicine mosquitoes, Black flies, Sand flies, biting midges, horse flies, deer flies and clegs, tsetse flies, house flies, myiasia producing flies, (blow flies, blue bottles, green bottles, flesh flies, warble flies and bot flies). The study will cover following aspects: Morphology, anatomy, distribution, breeding habits, life-cycle, pathogenesis and seasonal prevalence of the species. Brief account of diseases spread by these vectors, methods of control, modern trends in their biological and chemical control.

Practical

Methods of identification; Dissection of selected vectors i.e. mosquito, house flies, blue bottles, green bottles and bot flies. Study of prepared slides of parasites. Epidemiological studies of Vector born diseases (one e.g. malaria) including field studies of control methods and parasite evaluation.

Recommended Books

1. William A. Riley. Medical Entomology. McGraw Hill Book Co. Inc. London.
2. McDonald, G. The Epidemiology and Control of Malaria, London Oxford Press.
3. World Health Organization. Vector Control Series, Training and information guide. The House fly.
4. World Health Importance Geneva, WHO, 1988.
5. Walker, A. 1998. Arthropods of human and domestic animals. A guide to preliminary identification. Chapman & Hall.

6. Service, M.W. 1980. A guide to medical entomology. The McMillan Company, New York.
7. Herms, W.B. and James, M.T. 1960. Medical entomology. The McMillan Company, New York.

ZOL-4214 ANIMAL PESTS AND DISEASE PRODUCING ORGANISMS
Cr. Hrs. 2+1

Aims and Objectives

The course aims to provide knowledge and awareness to students about the different invertebrates and invertebrates animal pests and to equip the student with suficient knowlege to generate technologies and strategies being used for pest and disease management include testing new pesticides (chemical and biological) for inclusion in integrated pest management (IPM), to counter this challenge.

Course Contents

Nature and mechanism of damages caused by animals pest injuries to cash crops, vegetables and fruit plants, stored grains and forest plants with brief description of their biology, ecology and control. Role of insects, helminthes, nematodes, protozoans and other pathogens in disease transmission and myiasis. Insects and mites of medical and veterinary importance in Pakistan. Study of mammalian pests of Pakistan.

Practical: Collection, mounting studying and identification of important animal pests. Endo and ecto-parasite of various animals. Mounting of slides after processing the parasites.

Recommended Books

1. Ahmad, M., 1990. Agricultural Entomology of Pakistan. Nalt. Long Auth, Islamabad.
2. Choudhry, G.U. 1970. Survey of insect fauna of forests of Pakistan.
3. Ghani, M.A. and Cheema, M.A. 1973. Biology, ecology and behaviour of principal natural enemies of major insects pests of forests of Pakistan.

USDA, 1956. Year Book of Agriculture, Insects.

ZOL-4215 FISH PHYSIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide sufficient knowledge about all physiological phenomena in fishes. The subject provides Practical information to obtain better growth by following physiological aspects during extensive or semi-intensive culture.

Course Contents

Food digestion and nutrition. blood circulation, respiration, excretion, reproduction, learning and memory. Ethyological analysis of fish behaviour. Biological rhythm and fish migration.

PRACTICAL

Study of the different species of fish to acquire knowledge of the major feeding types with special emphasis on feeding adaptations and modification in the shape of the mouth. Study of adaptations for air breathing. Study of adaptation for air breathing among fishes and study of accuracy respiratory structure in fishes. Determination of O_2 and NH_3 in water.

Recommended Books

1. Lagler, K.F., (1977). Ichthyology.
2. Norman, J. R. And Greenwood, P.H. (1975). A History Of Fishes.
3. Kestin, S. C. And Warris, P. D. (Edition). Kestin Farmed Fish Quality, 2002. Blackwell Science, Oxford, UK.
4. Saksena, D. N. Ichthyology: Recent Research Advances. 1999. Oscar Publications. India.

ZOL-4216 ICHTHYOLOGY (FISH MORPHOLOGY) Cr. Hrs. 2+1

Aims and Objectives

The purpose of this course is to provide students with a thorough introduction to fundamental ichthyology with emphasis on aspects of fish anatomy, biology and form and function.

Course Contents

Basic Morphology, Systematic, Zoogeography of fin fishes, shell fishes and crustaceans with special references to Pakistan. Brief survey of world fisheries and non-fish resources. Fishing Technology, fish preservation, Shelf life of fisheries of various types.

PRACTICAL

Collection and identification of local fishes (fin fishes and shell fishes) and study of anatomy of selected fishes.

Recommended Books

1. Lagler, K.F. (1977). Ichthyology.
2. Norman, J.R. and Green wood, P.H. (1975). A history of fishes.
3. Kestin, S. C. and Warris, P. D. (Edition). Kestin Farmed Fish Quality, 2002. Blackwell Science, Oxford, UK.
4. Huet M. Text Book of Fish Culture: Breeding and Cultivation. 1973. Blackwell Publishing Company.

ZOL-4217 LIMNOLOGY-B Cr. Hrs. 2+1

Aims and Objectives

Limnology is the study of inland waters – lakes (both freshwater and saline), reservoirs, rivers, streams, wetlands, and groundwater – as ecological systems interacting with their drainage basins and the atmosphere. The limnological discipline integrates the functional relationships of growth, adaptation, nutrient cycles, and

biological productivity with species composition, and describes and evaluates how physical, chemical, and biological environments regulate these relationships.

Course Contents

Dynamics of lotic and lentic series, Organisms in lotic and lentic environments, Influence of physical and chemical conditions on biota and their adaptations to physical and chemical conditions, Bacteria and other fungi, Nektons, Biological productivity.

PRACTICAL

Collection, preservation and study of fauna and flora of various approachable water bodies; preparation of slides of microfauna and flora, identification, study of adaptive characteristics of animals and plants.

Recommended Books

1. Agrawal, S.C. 1999. Limnology. A.P.H. Publishing Corporation, N. Dehli.
2. Goldman, C.R. and Home, A.J. 1983. Limnology, McGraw Hill, International Book.
3. Welch, P.S. 1968. Limnology 8th Edition, McGraw Hill Book Co.l Inc., New York.
4. Singh, H.R. Advances in Limnology. Narendra. Publishing House, N. Delhi.
5. Allen S.E. 1990. Chemical Analysis of Ecological Materials. Scientific Publishers, London.

ZOL-4218 VERTEBRATA Cr. Hrs. 2+1

Aims and Objectives

The course provides knowledge and understanding about the classification, characteristics and physiological adoptation of different vertebrate animal groups, emphasizing their phylogenetic relationships.

Course Contents

Protochordates; Characteristics of vertebrates; Classification of vertebrates up to orders with examples, excluding Fossils except Archaeopteryx. Comparative vertebrates morphogenesis: Egg type, Cleavage, Blastula, Gastrulation, detailed account with support from Spemann's experiments. Comparative Anatomy and function of integumentary skeletal (General details such as structure of bones, cartilage, limb, evolution of limbs, digestive, circulatory, respiratory, excretory and nervous (including sense organs) system.

PRACTICAL

1. Museum study: Identification of common vertebrates and lower chordates.
2. Examination of the following prepared Slides
3. Whole mount of Amphioxus sp. T.S. Amphioxus through different regions. Pharynx of ascidians. Sections of skin of fish, frog and rabbit. Section of mammalian liver, kidney, spleen, thyroid gland, testes, ovary, heart muscle,

pancreas, nerve card, lungs and Intestine etc. Whole mounts and histological sections of different developmental stages of chick.

Recommended Books

1. Kent, G.C. Comparative Anatomy of the Vertebrates .Mosby Company.
2. Hashmi, T. H. and Bhatti, H.K. Chordate Zoology. Carvan book house Lahore.
3. Romer, A.S. (1962). The Vertebrate Body. W. B. Saunders Company, Philadelipha.

ZOL-4219 ORNITHOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course provides knowledge about general characteristics, classification, behaviour, evolution and geographical distribution of birds and will help to understand the basic physiological adaptations of birds with reference to different environmental conditions.

Course Contents

Introduction, evolution, geographical distribution and classification. Characteristics of birds, external features, identification of sex and age, reproduction and development, behaviour (migration, territoriality), populations and their regulation. Anatomical, physiological adaptations to their environment, reproductive strategies, food/feed, communication (vocal, behavioural). Anatomy & physiology of game and predatory species. Birds of Pakistan: Aquatic, Forest, Game birds and birds of prey. Birds as pests.

Practical

1. Visit of PMNH for study of preserved specimens of different groups of birds in relation to their taxonomy and ecosystem etc.
2. Field visits for bird watching (population estimation, nesting, vocal calls, feeding & other behaviours etc.) in different ecologies in the vicinity of Muzaffarabad areas.
3. Visit to zoos and wildlife parks.

Recommended Books

1. Kaiser, G. W. (2008). The Inner Bird: Anatomy and Evolution. Amazon Co.
2. Howell, S. N. G. (2010). Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.
3. Richard Grimmett, Carol Inskipp and Tim Inskipp (2008). Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton Book Co.
4. A J Urfi (2009). Birds of India: A Literary Companion, OUP.
5. Frank B. Gill. (2004). Ornithology. 2nd Ed. W. H. Freeman & Co.
6. Handbook of Bird Biology by Cornell Lab of Ornithology. Princeton University Press. New Jersey. 2004.

7. Salim Ali and S. Dillon Ripley (2001). Handbook of the Birds of India and Pakistan: Together with Those of Bangladesh, Nepal, Bhutan and Sri Lanka/. Reprint. New Delhi, Oxford University Press, 10 Vols.
8. Noble S. Proctor, Patrick Lynch, Patrick J. Lynch, Patrick J. Lynch (1998). Manual of Ornithology: Avian Structure and Function. Yale University Press.
9. Audubon Handbook: How to Identify Birds? 88th ed. Mcgraw-Hill Publishing Company.
10. Roberts, T.J. 1992. Birds of Pakistan. Vol 1& 2. Oxford University Press.

ZOL-4220 MAMMALOGY Cr. Hrs. 2+1

Aims and Objectives

The purpose of this course is to acquaint students with the origin, evolution, identification, characteristics, systematics, life history, and adaptive strategies of the Mammalia and to expose them to field techniques used in their study.

Course Contents

Classification of mammals (including Mesozoic mammals: Triconodonts, Symmetrodonts, Multituberculates, Docodonts and pantotheres); Mammalian characteristics; The Monotremes, Marsupials and Placental mammals; Specialization of Mammalian teeth; Mammalian molar and its origin (Tritubercular Theory); Distribution, Dispersal; Territory and Territoriality; Classification of mammals according to their diet; Food and food storage in mammals; Hibernation and Aestivation; Defense and Protection; Movement in mammals (running, leaping, fossorial, swimming, arboreal, flying and gliding mammals); Origin and evolution of mammals.

PRACTICAL

1. General survey and classification up to species of important mammals
2. Skeleton of Mongoose or Cat, Hedgehog and Rabbit.

Recommended Books

1. Terry, A. Vaughan, J.M. Ryan and N.J. Czaplewski, 2009. Mammalogy 5th Ed. Jones and Bartlett Publishers.
2. F. Harvey, Pough, Christine, M. Janis, John, B. Heiser. Vertebrate Life. 2003. Pearson Education.
3. Hickman, Roberts, and Larsen, 2005, Integrated principles of Zoology (13th Edition). McGraw Hill, New York.
4. David, D., 1963. Principles of Mammalogy.
5. Davis. Principles of Mammalogy.
6. Gelder, Biology of Mammals.
7. Miller and Harley, 1999. Zoology (8th Edition).
8. Hickman, Roberts, and Larsen, 2001. Integrated Principles of Zoology (11th Edition).

ZOL-4221 WILDLIFE Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to familiarize students with wildlife, its values, ecology and management with special reference to Pakistan and AJK by: (1) exploring the ecological processes affecting wildlife, and (2) discussing various national and international measures and challenges in conserving wildlife.

Course Contents

Introduction to wildlife, Wildlife of Pakistan, Identification, classification, distribution, and conservation status of mammals, birds, reptiles & amphibians of Pakistan & AJK. Introduction to major wildlife habitats in Pakistan/AJK. Philosophy and significance of wildlife conservation. Conservation of wildlife: *in-situ* and *ex-situ* conservation approaches. Wildlife management in Pakistan/AJK. Wildlife laws/regulations in Pakistan/AJK. National and International agencies involved in conservation and management of wildlife. Introduction to some modern techniques (Radio telemetry, remote camera, TIR, GPS, GIS, RS, molecular analysis) used in wildlife conservation. Protected areas (Sanctuaries, Game Reserves and National Parks) in Pakistan/AJK. Human-wildlife conflict and its mitigation.

PRACTICAL

1. Study of museum specimens and their classification (Birds and Mammals)
2. Demonstration of distribution of avian and mammalian fauna of Pakistan. (Blank maps may be provided).
3. Study of Birds and mammals censing techniques.
4. Use of GPS in field studies.
5. Visit of Zoos and protected areas

Recommended Books

1. Roberts, T.J. (1997). Mammals of Pakistan. Oxford University Press, Karachi.
2. Bailey, J.A., 1986. Principles of Wildlife Management, John Wiley.
3. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing & Co. London, UK.
4. Grimmett, R. Inskipp, C. and Inskipp, T., 2001, Birds of the Indian Sub-Continent. Helm.
5. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
6. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition).McGraw Hill, New York.
7. Hickman, Roberts, and Larsen, 2008. Integrated principles of Zoology (12th Edition).McGraw Hill, New York.
8. Jordan, E. L. and Verma, P. S. 2011.Invertebrate Zoology, S. Chand and Company.
9. M.S. Khan. 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Florida USA.
10. M. M. Shafique, 2005. Wildlife Acts and Rules of Pakistan. PFI, Peshawar.

11. Miller and Harly, 2007. Zoology (7th Edition). McGraw Hill, New York.
12. Mirza, Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
13. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 8th ed. John Wiley & Sons, Inc.
14. Azad Jammu and Kashmir, Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 2009
15. Roberts, T. J. 1991. Birds of Pakistan. Vol. I Oxford University Press
16. Roberts, T. J. 1992. Birds of Pakistan. Vol. II. Oxford University Press
17. Roberts, T. J. 2005. Field Guide to the large and Medium-sized Mammals of Pakistan. Oxford University Press
18. Roberts, T. J. 2005. Field Guide to the small Mammals of Pakistan. Oxford University Press.
19. Robinson, W.L. and Bolen, E.G., 1988. Wildlife Ecology and Management. McMillan, Cambridge.
20. Akbar, G and M. Anwar (Eds.). 2011. Wildlife of Western Himalayan Region of Pakistan (Northern Mountains). WWF-Pakistan. 378pp.

ZOL-4222 ENVIRONMENTAL ISSUES Cr. Hrs. 2+1

Aims and Objectives

This course is designed to provide students with an appreciation for the complexity of environmental issues and an awareness of the tools that can be applied to understand and solve problems involving the environment.

Course Contents

Life a factor of rapid change in the environment, Population increase of diversified life in an ecosystem, Population system in an ecosystem balance; Mechanisms inter-playing in balance, consequences of imbalance, Endangering and extinction of species, decline of biodiversity, consequences of losing biodiversity. Human population: Main actor in an environment, Human population explosion, Technologies in sustaining population and affluence, addressing population problem, population and development. Poverty; integrated approach to alleviate poverty, Life style: Urban sprawl, consequences of ex-urban migration, Health in life style; Environment and health. Food production (Crops and livestock). Land for cultivation and farming. Food production, its distribution, economics and politics, Hunger, malnutrition and famine, Soil, irrigation, Stalinization, Desertification, Losing soil/ground. Pests and pest controls: Need and approach to pest control. Alternate pest control methods. Socio-economic pressure and pest management, Environmental policy in pest management. Water: Water cycle and water management, Human impact on water resources. Pollution. Bi-products of production systems: Sediments, Nutrients and eutrophication, the process and symptoms of eutrophication, combating eutrophication, long term strategies. Sewage pollution: Sewage hazards and potential, sewage management, recycling and impediment to recycling. Hazardous chemical pollution: Nature and chemical risks, pollution sources

and control. Major atmospheric changes: Acid deposition, Global warming/cooling, Green house effect, Ozone depletion. Solid wastes (trash): Landfills, combustion, solutions and management. Energy resources (Fuel of production and development): energy sources and uses, fossil fuel, alternate fossil fuel; Nuclear Power, promises and problems, sustainable energy option, solar and other renewable energy sources. Environmental issues of Pakistan: Ecological issues (Soil erosion, deforestation, issues related to irrigated system, natural hazards), issues related to conservation of habitat and biodiversity (major threats to biodiversity in Pakistan, conservation strategy), pollution and industrial resources (water issues, air issues, soil issues, mineral resources issues, energy issues, food, population issues and socio-economic issues.

Practical

Review, reports, field trips, discussions on current local, national, regional and global issues. Approaches and strategies, mitigation measures.

Recommended Books

1. Botkin, D.B. and Keller, E.A. 2008. Environmental science (Earth as a living planet). 3rd Ed. John Wiley and Sons Inc. N.Y, USA.
2. Ahmad, R.Z. 2000. Pakistan-A-descriptive Atlas (A comprehensive geopolitics Course). 1st Ed. Ferozsons Pvt. Ltd. Lahore Pakistan.
3. Nebel, B.J. and Wright, R.t. 1998. Environmental Sciences (the way the world works). 1st Ed. Prentice Hall International Inc. London, UK.
4. Gaston, K.J. and Spicer, J.I. 1998. 'Biodiversity (An Introduction), 1st Ed. Blackwell Science Ltd. UK.
5. Brandbury, I.K. 1998. The Biosphere. 2nd Ed. John Wiley and Sons Inc. UK.
6. Mckinny, M.L. and Schoch, R.M 1998. Environmental Science (systems and solutions). Jones and Artlett Publications Inc. USA.
7. Emiliani, C. 1997. Planet Earth (Cosmology, geology and the evolution of life and environment). 3rd Ed. Cambridge. University Press, UK.
8. Khan, F.K. Geography of Pakistan Environment (Environment, People and economy). 1993. Oxford University Press, NY, USA.
9. Hussain, S.S. 1992. Pakistan manual of plant ecology (A text book of plant ecology for degree students). National Book Foundation, Islamabad, Pakistan.
10. Daily news papers for current issues.

ANNEXURE-IV

CURRICULUM FOR M. SC. IN ZOOLOGY

DEPARTMENT OF ZOOLOGY

MIRPUR UNIVERSITY OF SCIENCE & TECHNOLOGY MIRPUR (AJ&K)

Introduction

This degree program aims to impart the fundamental concepts of zoology as applicable under recent advances and practical users under condition of region. This will enable the young students to understand principles of organization and interrelation in the biological systems, which are important for better research, planning and management of animal resources, environment, health and medicine, and population in the country. Program consists of two years, at the successful completion of M. Sc., graduates has a wide option to hunt a job in government and private sector and abroad.

MISSION STATEMENT

This degree program aims to develop conceptual understandings in the field of zoology, enabling student to apply their knowledge to the betterment of the society.

PROGRAM OBJECTIVES

1. Perceive the significance and extent of the field of zoology in modern era.
2. Achievement of mastery in the basic, advanced and current trends in zoology, prompt a curious, critical and scientific approach toward zoological problems
3. Develop proficiency in the use of laboratory and equipments, practical work, experimentation, collection and interpretation of materials and data.
4. Equip student with strong oral/written communication skills, interdisciplinary and collaborative approaches.
5. Develop morality and professional behaviour in the students.

Program Outcomes

At the completion of M. Sc. Degree in Zoology, students would be able to;

1. Find their places in society and market where they could use their skills.
2. Have a background and updated knowledge of zoological issues and a vision to tackle with them.
3. Identification of priority problems, analysis and designing of their solutions by using new analytical techniques.
4. Communicate their knowledge effectively and have a new insight toward integrated approaches.
5. Encompass high moral values and would be useful to the society.

Scheme of studies for M.Sc Zoology w.e.f. 2015-17 & onward

Duration 4-6 Semesters

Courses	58 Credits
Thesis/Special Papers	06 Credits
Comprehensive Oral Examination	S/U basis
Total Credits	64

COURSE CONTENTS OF COMPULSORY FACULTY COURSES FOR M. SC. PROGRAM IN ZOOLOGY 1ST SEMESTER

YEAR-I

SEMESTER-I (Cr. 17)

Course code	Course title	Credits	Status
ZOL-5101	Molecular Cell Biology	3+1	Major-I
ZOL-5102	Animal Physiology	3+1	Major-II
ZOL-5103	Genetics	3+1	Major-III
ZOL-5104	Environmental Biology	2+1	Major-IV
ZOL-5105	Evolution	2+0	Foundation-VII
	Total Credits	**17**	

ZOL-5101 MOLECULAR CELL BIOLOGY Cr. Hrs. 3+1

Aims and Objectives

The objectives of the course are to impart knowledge about the animal cell and its complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms. The 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). Ultra structure, chemical composition and functions of Endoplasmic Reticulum with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus, Mitochondria, Lysosome, peroxisome, glycoxysome. **Nucleus,** chromatin, heterochromatin, euchromatin, Replication (mechanism, DNA replication in prokaryotes specially with reference to variety of DNA polymerases and other proteins involved, DNA replication in Eukaryotes, Transcription (variety of RNA and their characteristics, synthesis of mRNA, rRNA and tRNA, RNA splicing, split genes, concept of Ribozymes and posttranscriptional processing), RNA transduction, Genetic code, point mutations, Translation. Control of gene expression in prokaryotes.

Practical:

1. Isolation of chromosomal DNA and RNA from bacteria, fungi and yeast.
2. Detection and quantitative determination of chromosomal DNA and RNA through gel electrophoresis techniques.
3. Isolation of plasmid from bacteria, fungus and yeast.

Recommended Books

1. Damnell Jr .J; Lodisch, H. and Baltimore, D (1990). Moleculer Biology, Scientific American Inc.N.Y.
2. Alberts B., Brary, D., Lewis, J., Raff, M., Roberts, Kand Watson, J.D. (1989). Moleculer Biology of Cell.Garland Publishing Inc. New York.
3. De Robertes, E.D.P. And De Robertis Jr, E.N.F. (1987). Cell and Moleculer Biology. Laea & Febiger New York
4. Karp, J. Cell and Molecular Biology, Concepts and Experiments, 2005. John Willey and Sons, INC.
5. Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, 2007. Sinauer Associates, INC.

ZOL-5102 ANIMAL PHYSIOLOGY Cr. Hrs. 3+1

Aims and Objectives

The course aims to:

1. Understand basic physiological mechanisms relating to membrane excitability, nerve and muscle, receptor function.
2. Understand neuro-endocrine coordination and secretions of glands.
3. Know the physiology of heart, hemodynamic system and kidney function.
4. Understand the digestive physiology and nutritive functions of gut.
5. Understand physiological regulation of temperature and its maintenance

Course Contents

Central themes in Physiology: Homeostasis, Concepts of conformity and regulation; physiological adaptations. **Neuro-muscular physiology:** Cellular homeostasis, resting and action potential, synaptic transmission, muscle contraction, general sensory mechanism, cutaneous sensation, audition, vision, taste, olfaction, the motor control system, sleep and consciousness. 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. **Cardiovascular Physiology:** Vessels, heart, electrocardiography, cardiac rate, rhythm, and conduction disturbances, heart as a pump, cardiodynamics, hemodynamics, cardiac output and venous return, control of cardiovascular system, responses to stress. **Respiratory physiology:** Respiratory mechanics, gas exchange between atmosphere and the body, gas transport, pulmonary circulation, respiratory control, hypoxia. **Renal Physiology:** Body fluid compartment, renal tubular function, renal clearance, glomerular filtration and GFR, reabsorption and secretion, composition of urine, formation of dilute and

concentrated urine, effect of ADH, Aldosterone and Atrial Natriuretic Factor on renal physiology. **Gastrointestinal Physiology:** Digestive system, the oral cavity, composition of saliva, pharynx, oesophagus, the stomach, regulation of gastric juice, small intestine, liver, regulation of bile, pancreatic and intestinal enzymes and their regulation, the colon, absorption of nutrients. **Endocrine Physiology:** General features of hormones, types of hormone action, basic concepts of endocrine control, endogenous opioid peptides, pituitary gland, thyroid gland, parathyroid hormones, calcitonine, Vitamin D. Adrenal Medulla, Adrenal cortex, Testis, Ovary, Endocrine placenta, Endocrine Pancreas. **Temperature Regulation:** Temperature classification of animals; Temperature relation of ectotherms in freezing, cold, warm and hot environment; costs and benefits of ectothermy; Temperature relations of heterotherms and endotherms; Dormancy: Sleep, Torpor, Hibernation and Aestivation.

Practical:

1. **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.
2. **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.
3. **Cardiovascular Activity:** Normal cardiac activity, effect of temperature, effect of drug, heart block, tetanization of heart. Measurement of blood pressure.
4. **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.
5. **Endocrine and Reproductive Mechanisms:** Effect of insulin on glycemia, study of stages in estrous cycle.
6. Study of RBCs count and TLC

Recommended Books

1. Randall, D., Burggren, W., French, K. and Fernald, R. Eckert Animal Physiology: Mechanisms and Adaptations, 5th Edition. 2002. W.H. Freeman and Company, New York
2. Bullock, J., Boyle, J. and Wang, M.B. Physiology, 4th Edition. 2001. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N. Principles of Physiology, 3rd Edition. 2000. St. Lious, Mosby.
4. Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, 10th Edition. 2000. W.B. Saunders Company, Philadelphia.

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

ZOL-5103 GENETICS Cr. Hrs. 3+1

Aims and Objectives

The continuity of the life from one generation to other generation is based on the mechanisms involving nucleus, chromosomes and genes etc. The process of continuity not only transfers the traits of the parents but also imparts variations that render the generations sustainable in changing environment. These concepts will be imparted to the students in this course.

Course Contents

Classical genetics: Scope and importance of genetics, gene concept (classical and modern), **multiple alleles,** blood groups and coat color in rabbits, **Chromosomal basis of inheritance:** interaction of genes, chromosomal changes (euploidy, aneuploidy, structural changes), Karyotyping-Normal human chromosome complement. Pedigree Analysis. **Sex-determination and sex-linkage:** Sex determination in animals and humans, linkage, recombination and chromosome mapping in eukaryotes, quantitative inheritance. genetics of viruses, bacteria, transposons. **Molecular genetics** – analysis and techniques of molecular genetics (elements of genetic engineering), genetic basis of cancer, genetic control of animal development, the genetic control of the vertebrate immune system, complex inheritance patterns. **Human Genetics:** Autosomal anomalies, Pseudoautosomal genes, (e.g. Down's syndrome, Edward's syndrome and Cri Du Chat syndrome), Single gene disorders Gene mutation and disorders (Brief mention) Autosomal single gene disorders (Sickle cell anemia, brachydactyly; inborn errors of metabolism such as phenylketonuria, alkaptonuria). Definition - characteristics criss-cross inheritance. Multifactorial disorders - Polygenic traits - Cleft lip and cleft palate, Sex-linked and sex-influenced inheritance: Haemophilia and colour blindness. Sex chromosomal anomalies (Klinefelters syndrome, and Turner's syndrome). **Prenatal Diagnosis:** (Amniocentosis) and choriovillus sampling-Ultrasound scanning and Fetoscopy. Genetic counselling, Eugenics and Euthenics. **Population genetics**–Hardy-Wienberg equilibrium, systematic and dispersive pressures, inbreeding and heterosis.

Practical:

1. Mitosis (Onion root tips.)
2. Meiosis (Grass hopper testes)
3. Blood groups.
4. Salivary gland Chromosomes of *Drosophila melanogaster*
5. General morphology of *Drosophila melanogaster*
6. Human Pedigree analysis problems

7. Human Genetics problems
8. Probability problems. Tossing of coins. X^2 test
9. Study of transformed bacteria on the basis of antibiotic resistance.

Recommended Books

1. Snustad, D.P. and Simmons, M.J. Principles of Genetics. 3rd Edition, 2003. John Wiley and Sons Ins. New York, USA.
2. Tamarin, R.H. Principles of Genetics. 7th Edition, 2001.WCB publishers USA.
3. Gardener, E.J., Simmons, M.J. and Snustad, D.P. Principles of Genetics. 1991. John Wiley and Sons Ins. New York, USA.
4. Stickberger, M.W, (1985). Genetics, McMillan, N.Y.
5. Herskowitz, I.H. (1985). Genetics, Little Brown, Bostan.
6. White-House, H. L. K. (1965). Towards an understanding of mechanism of heredity
7. Crow, J.F. (1976). Genetics notes Burgess Publishing Company, Minneapolis.
8. Mays L.L. (1989).Genetics –A Molecular Approach, McMillan and Company N.Y.
9. Lewin, B. (2000). Gene VIII, Oxford University Press, UK.

ZOL-5104 ENVIRONMENTAL BIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The main goal of this course is to enable the students to develop strong expertise in contemporaneous themes in environmental biological research and to be able to discuss these issues in a broad context. The students will be able to think and discuss about advanced topics in ecosystem ecology, types, interactions, pollution types and causes and their solution.

Course Contents

Concept of living **environment and global ecosystem** (Atmosphere, Hydrosphere, Lithosphere, Biosphere, Ecosphere). Urban ecosystem. **Interactions in ecosystem**, Concept of energy flow and biogeochemical cycles. Disturbance in ecosystem. Environmental resources and their conservation (Mineral resources, Agriculture and forestry, Agriculture land use, Range management, Desalination and Weather modification).

Environmental pollution: Air pollution. Major and minor atmospheric pollutants (CO2, CO CS2, O3, Smog and PAN1 NOX NH3 Ethylene, dust, sources origin dispersion and impact of these pollutants on human, Crops & Forest. Water pollution. Domestic and industrial effluents.

Energy: Various forms of energy, utilization and environmental impact, energy crises. Radiation Biology, Space Biology, Exobiology, Extra biosphere environment.

High Altitude Ecology, Ocean Ecology. Contemporary environmental themes (Zone depletion, Green house effect, global warming, Acid Rain, desertification, deforestation).

Practical:

1. Analysis of aquatic and terrestrial ecosystem.
2. Pollution dynamics of grasshoppers.
3. Capture and recapture methods.
4. Adaptive feature of animals in relations to food and environment.
5. Food chain of local wild birds in various seasons.
6. Study of polluted areas and their impact on animal and plant life.
7. Analysis of urban (polluted) air for NO_2, SO_2 and O_3 pollutants and comparison with back ground rural air.
8. Effect of industrial effluents and smoke on animal life.
9. Analysis of polluted and fresh water for various effluents (CI, CO_3-HCO_3-, NO_3-, BOD, COD, pH, EC), total soluble and suspended solids, etc.
10. Impact of radiation on microbes and plant life.
11. Effect of noise on animal behaviour, a survey of endangered species, Visit to National Parks.

Recommended Books

1. Odum, E.P.,(1987). Fundamental of Ecology ,W.B. Saunders
2. Smith,R.L.,(1980). Ecology and Field Biology, Harper and Row.
3. Bebel,BJ., (1981).Environmental Science, Prentice Hall Inc.
4. Balley, J.A., (1986). Principles of Wild Life Management, John Wiley.
5. Ali S. &Ripley S.D., (173). A Handbook of Birds of India & Pakistan, Oxford University Press, Landon.
6. Robert, T.J., (1991). The birds of Pakistan Vol.1.Oxford University Press.
7. Robert, T.J. (1992) the bird of Pakistan. Vol.11.oxford University Press.

ZOL-5105 EVOLUTION Cr. Hrs. 2+0

Aims and Objectives

This course intends to the understandings of basic concepts (definition, types) and history of evolution, understanding and analysis of most influential theories of evolution, phenomenal processes that control, regulate evolution and correlate modern knowledge and concepts of phenomenal processes and theories of evolution.

Course Content:

The nature and origin of life. Theories to explain the diversity of life: Lamarckism, Darwinism and special creation. The present status of these theories. The species as

key stone of evolution. Species Concepts, Kinds of Species. 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-evolution)-allometry, orthogenesis, adaptive radiation.

Modern concept of Natural Selection: Levels of action, direction, intensity, laboratory and field experiments to demonstrate the action of Natural Selection. Action of Natural Selection leading to convergence, radiation, regression and extinction.

Recommended Books

1. Dobzhansky,T., (1970).Genetics of evolutionary process, Columbia University Press, NewYork.
2. Sheppard, P.M. (1958).Natural Selection and Heredity, Hutchison University Library, London.
3. Dobzhansky, T.Genetics and the Origin of Species, Columbia University Press, NewYork.
4. Mayr, E. Populations, Species and Evolution, Harvard University Press.
5. Moody, P. A., (1989). Introduction to Evolution, Harper and Row Publishers, New York.
6. Caln, A. J.(1963). Animal Species and their Evolution, Hutchinsons University Library, London.

COURSE CONTENTS OF COMPULSORY FACULTY COURSES FOR M. SC. PROGRAM IN ZOOLOGY 2ND SEMESTER

SEMESTER II (Cr. 17)

Course Code	Course title	Credits	Status
ZOL-5201	General Biochemistry	3+1	Foundation-VIII
ZOL-5202	Developmental Biology	3+1	Major-V
ZOL-5203	Principles of Animal Taxonomy	2+1	Major-V

ZOL-5204	Biostatistics	2+1	Major-VI
ZOL-5205	Paleontology	2+1	Major-VII
	Total Credits	**17**	

ZOL-5201 GENERAL BIOCHEMISTRY Cr. Hrs. 3+1

Aims and objectives

- The course will provide (in depth) knowledge about the polymerized organic compounds of life.
- The dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It will deal with the inter-conversion and is performed by various tools called as enzymes.
- Thus, in this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Learning outcomes

- Student will be able to demonstrate the polymerized organic compounds of life, the chemical basis of life and various mechanisms involved in harvesting of energy for growth, duplication and other necessary functions of life.
- Students will be able to develop research skills and knowledge of research techniques and instrumentation by means of class lectures and lab practices.
- Students will be able to perform basic biochemical tests including detection of carbohydrates, amino acids, solubility of lipids and enzyme activity.

Course Contents

Amino acids, peptides and proteins: standard amino acids, their structure and classification; acid-base properties of amino acids and their titration curves; peptides, their ionic behavior and amino acid composition, cytochrome c; Macromolecular separation techniques in biochemistry; ion exchange chromatography; isoelectric focusing; density gradient centrifugation. **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 enzyme activity. **Carbohydrates:** classification, types, important characteristics and structure of carbohydrates; history of developments in structure of glucose; monosaccharides; cyanohydrin 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 of 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 of glycogen and starch; regulation of glycogen metabolism; utilization of dietary polysaccharides (starch) and disaccharides (sucrose and galactose). **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. **Lipid metabolism:** oxidation of fatty acids; digestion, mobilization and transport of fats; biosynthesis and 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) multienzyme complex; biosynthesis of unsaturated fatty acids. 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. Neucleotide metabolism.

Recommended Books

7. Nelson, D. L. and Cox, M.M. Lehninger Principles of Biochemistry, 3rd Edition, 2000. McMillan Worth Publishers, New York.
8. Murray, R.K., Granner, D.K., Mayer, P.A. and Rodwells, V.W. Harper's Biochemistry, 25th Edition, 2000. McGraw Hill, New York.
9. Voet. D., Voet, J.G., and Pratt, C.W. FUNDAMENTALS OF BIOCHEMISTRY, 1999. John Wiley and Sons, Inc., New York.
10. Zubay, G. Biochemistry, 4th Edition, 1995. Wm. C. Brown Publishers, Inc., Oxford, England.
11. Lubert, S. Biochemistry, 4th Edition, 1995. W.H. Freeman & Company, New York.
12. McKee, T. and McKee, J.R. Biochemistry, The Molecular Basis Of Life. 3rd Edition, 2003. McGraw Hill.

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

13. Tests for detection of carbohydrates in alkaline and acidic medium.
14. Tests for detection of Disaccharides.
15. Detection of Non-Reducing sugars in the presence of Reducing sugars.
16. Demonstration of Acid Hydrolysis of Polysaccharide.
17. Separation and identification of various types of sugars, fatty acid and amino acid, Thin Layer Chromatography (TLC).
18. Determination of pKa values of an amino acid by preparation of titration curves.
19. Biochemical tests for detection of different amino acids.
20. Separation of various protein fractions by precipitation method.
21. Demonstration of differential solubility of lipids in various solvents.
22. Quantitative analysis of phospholipids by estimation of inorganic phosphorous.
23. Quantitative analysis of Amylase activity from blood serum or liver.
24. Study on the effect of temperature on the enzymatic rate of reaction

Recommended Books

3. Plummer, David T. An Introduction to Practical Biochemistry, 1990. 4th Edition McGraw-Hill Book Company, London.
4. Wilson, K & Walker, J. Practical Biochemistry: Principles and Techniques, 4th Edition, 1994. Cambridge University Press.

ZOL-5202 DEVELOPMENTAL BIOLOGY Cr. Hrs. 3+1

Aims and Objectives

The course will provide detailed knowledge about the principal features of development, cellular basis of morphogenesis, mechanisms of cellular differentiation and concepts of induction in development. It will provide understanding of the mechanisms of organogenesis, factors controlling growth and oncogenesis. The concept related to the theory in Developmental Biology will be practically demonstrated in this course. In the continuity of the animals during reproduction following the union of the traits from the parents in their gametes, the zygote proceeds through enormous phenomena of development up to their emergence resembling to the parents. The concepts of all these developmental mechanisms will be communicated to the students in this course.

Course Contents

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 nd 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.

Practical:

Study of structure of gametes in some representative cases, i.e., fish, frog, 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. Study of nematode larvae, developmental stages of mosquito.

Recommended Books

1. Gilbert, S. F. Developmental Biology, 2010. Sinauer Associates, Sunderland, MA.
2. Balinsky, B. I. An Introduction to Embryology, 1985. Saunders.
3. Saunders, J. W. Developmental Biology, 1982. McMillan and company.
4. Oppenheimer, S.S. Introduction to Embryonic Development, 1984. Allen and Bacon.
5. Ham, R. G. and Veomett, M. J. Mechanism of Development. 1980. C. V. Mosby Co.
6. Klaus, K. Biological Development. 2nd Edition, 2001.McGraw Hill.

ZOL-5203 PRINCIPLES OF ANIMAL TAXONOMY Cr. Hrs. 2+1

Aims and Objectives

The course is designed to provide in knowledge about the importance and history of animal systematics with basic rules and regulations about the identification and naming of organisms.

Course Contents

Definition and basic concepts of taxonomy, systematics and classification. Importance and application of systematics in animal science, brief history of taxonomy; Forms of classification: Taxonomic categories and hierarchies: The

Linnaean Hierarchy; 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; The basis and criteria of classification, Nomenclature (ICZN). Kinds of evidences, Similarity and Homology, Criteria of Homology, Serial Homology, Criteria for primitive and specialized characters, Parallelism. Monophyly and Polyphyly, Grades and Clades, Divergence and Diversity, Splitting and Lumping, Evolutionary basis of taxa. International codes of taxonomy, Systematics publications, Principle of priority and validity of names. Taxonomic Procedures: Taxonomic collection; their preservation and duration, Taxonomic keys, different kinds of keys and their merits and demerits.

Practical:

Study of preserved vertebrates and invertebrate species and their classification up to class level. Collection and preservation techniques, Identification of common animal species with the help of Key. Preparation of keys for the identification of specimens.

Recommended Books

1. V. C. Kapoor (2001) Principles and Practices of Animal Taxonomy (2nd edition), Science Publishers.
2. Simpson, G.G. (1990). Principles of Animal Taxonomy, Columbia University Press, N.Y.
3. Huxley, E. (latest edition). New Systematics, Oxford University Press.
4. Mayr, E. (latest edition). Animal species and evolution, Harvard University Press.
5. Scheuk and McMster. (Latest edition). Procedure in Taxonomy, Stanford University Press.
6. Mayr, E. and Ashlock, P.D. (latest edition). Principles of Systematics Zoology, McGraw Hill Inc. New York.
7. Rissm G.G. (latest edition). Taxonomy and Ecology. Addison-Wesley Publishing Co. Reading, Massachusetts.
8. Heywood, V.H. (latest edition). Taxonomy and Ecology. Academic Press, London.
9. Whili, M.J.D. (latest edition). Modes of Speciation, W. H. Freeman and Co. San Francisco.

ZOL-5204 BIOSTATISTICS Cr. Hrs. 2+1

Aims and Objectives

1. 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.

2. After this course students will be able to apply basic statistical procedures for analysis of data for practical and research.

Course and Practical Contents

Introduction and scope, use of statistics in biology. Population and sample, Stages of research, **Types of data**: methods of data collection. Data arrangement and presentation, formation of 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. **Handling of multiple samples**: Analysis of variance and LSD. **Correlation and regression**. Experimental designing, planning of an experiment, replication and randomization.

Recommended Books

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. Simpson, G.G., Roe, A. and Lewonhtin, R.C. (1960). Quantitative Zoology, Harcourt Bruce and Company.
5. Sokal, R.R. and Rohlf, F.J. (1973). An Introduction to Bio-statistics, Toppan.
6. Mather, K. (1960). Statistical Analysis in Biology. Methuen.
7. Bailey, N.T.J. (1981). Statistical Methods in Biology, English University Press.
8. Mishra, B.N. (1982). Introduction to Practical Biostatics.

ZOL-5205 PALEONTOLOGY Cr. Hrs. 2+1

Course Objectives

- ✓ The course imparts knowledge and concepts of Paleontology mainly based on the past fossil records.
- ✓ The fossil records also provide the information regarding the presence and distribution of animals in the past eras.
- ✓ This contents enable students to relate the studies of past environment and present Climatic Changes.

Learning Outcomes

- ✓ The course will impart knowledge of origin of life, and forces responsible for evolutionary changes and present status of paleontology.
- ✓ The students will be able develop strong paleontological observations in students.
- ✓ The Students will be able to understand evolutionary processes with special focus on GTS.

Course Contents

Introduction to paleontology. Disciplines in paleontology. Core branches of paleontology and their interrelationships. Fossils,Types of Fossils, Nature of fossils. Fosslization. Uses of Fossils. Paleoecology, Micropaleontology, Paleomagnetism. Index fossils and their use in biostratigraphy with special reference to Pakistan. Study of salt range with special reference to Pakistan. Pre-Cambrian life, Post-Cambrian life cambrian Explosion Paleo-proxy Record . Earth, Shells of earth; (atmosphere, hydrosphere, biosphere and lithosphere). Rock, types of rocks (lgneous rocks, sedimentary rocks and metamorphic rocks); Rock cycle, Significance of Rocks. Petrology, Study of Minerals. Geological time scale. Geochronometry and Application of Geo-chronometry in paleontology. Radiometric dating methods (Uranium/Lead dating, radiocarbon dating, methods). Uranium/lead dating, the use of zircon, Environmental issues related to Geomorphology (effect on Fossils Distribution): with special emphasis on plate Tectonics, Volcanoes, Earthquakes,Tsunami. Present status of paleontology and its practical application.

Practical:

10. Study of mold, casts, pseudomorphs, petrified fossils, imprints, foot prints
11. Preparation of Artifical Replicas by kneaded clay.
12. Study of fossils, coelenterates, crustaceans, brachiopods; trilobites molluscs and echinoderms.
13. Study of vertebrates fossils of evolutionary importance e.g. horse, elephant, camels and primates.
14. Isolation of Micro-fossils by different techniques and microscopic visualization.
15. Study and identification of igneous, sedimentary and metamorphic rocks.
16. Tree ring dating by Radio active isotopes of Carbon.
17. Use of different Radiometric technique; radiocarbon dating of ground water -practical applications.
18. Field survey of Archaeological site and Note down common features of site.

Recommended Books

15. Michael Foote and Arnold I. Miller, 2007. Principles of Palaeontology (3rd Ed.) Freeman and Company.
16. Michael, J.B. and David, A.T. Harper, 2009. Palaeobiology and the fossil record (3rd Ed.). Wiley Blackwell.

17. Dunbar, C.O. (1969). Historical Geology. JohnWiley & Sons, N.Y.
18. Brouwer, A. (1977). General Paleontology .Oliver and Boyd, London.
19. Gilbert, E.H. (1980). Evolution of Vertebrates, JohnWiely, New York.
20. Moore, R.C., Lallcker, G.C. and Fisher, A.G. Invertebrates Fossils. McGraw Hill, N.Y.
21. Romer, A. S. (1958). Vertebrates Paleontology. The University of Chicago Press.
22. Shrock, R.A. and Twenhoefel, W.W. (1953). Principles of invertebrate Paleontology McGraw, Hill, New York.
23. Dobzhansky, T., Ayala, F.J., Stebbins, G.L. and Valentine, J.W. Evolution. 1973. W.H. Freeman and Company.
24. Sheppard, P.M. (1958). Natural Selection and Heredity, Hutchison University Library, London.
25. Dobzhansky, T. Genetics and the Origin of Species, Columbia University Press, New York.
26. Mayr, E. Populations, Species and Evolution, Harvard University Press.
27. Moody, P. A. (1989). Introduction to Evolution, Harper and Row Publishers, New York.
28. Caln, A. J. (1963). Animal Species and their Evolution, Hutchinsons University Library, London.

COURSE CONTENTS OF COMPULSORY/ELECTIVE COURSES FOR M. SC. PROGRAM IN ZOOLOGY 3RD SEMESTER

YEAR-II

SEMESTER–III (Cr. 15)

Course code	Course title	Credits	Status
ZOL-63**	Elective-I	2+1	Elective
ZOL-63**	Elective-II	2+1	Elective
ZOL-63**	Elective-III	2+1	Elective
ZOL-63**	Elective-IV	2+1	Elective
ZOL-63**	Elective-V	2+1	Elective
ZOL-6424	Thesis (research work will be started in semester VII and the credit will be given in semester VIII)		Elective
	Total Credits	**15**	

LIST OF ELECTIVE COURSES FOR M. SC. PROGRAM IN ZOOLOGY III SEMESTER

Course code	Course Title	Lec. Hrs	Lab. Hrs	Credit Hrs.

ZOL-6301	Zoogeography	2	1	3
ZOL-6302	Reproductive Physiology	2	1	3
ZOL-6303	Clinical Endocrinology	2	1	3
ZOL-6304	Neurophysiology	2	1	3
ZOL-6305	Immunology	2	1	3
ZOL-6306	Hematology	2	1	3
ZOL-6307	Biotechnology-I	2	1	3
ZOL-6308	Biotechnology-II	2	1	3
ZOL-6309	General Toxicology	2	1	3
ZOL-6310	Human Genetics	2	1	3
ZOL-6311	General Microbiology	2	1	3
ZOL-6312	General Parasitology	2	1	3
ZOL-6313	Invertebrata	2	1	3
ZOL-6314	General Entomology	2	1	3
ZOL-6315	Principles of Fish Biology	2	1	3
ZOL-6316	Fisheries & Aquaculture	2	1	3
ZOL-6317	Limnology-A	2	1	3
ZOL-6318	Principles of Herpetology	2	1	3
ZOL-6319	Biodiversity	2	1	3
ZOL-6320	Histology	2	1	3
ZOL-6321	Biological Techniques	1	2	3
ZOL-6322	Research Methodology	2	1	3
ZOL-6424	Thesis	0	0	0

ZOL-6301 ZOOGEOGRAPHY Cr. Hrs. 2+1

Aims and Objectives

The course imparts knowledge and concepts of evolution based distribution of animals on the globe. This course provides information on the distribution of animals and their associations in the past; thus, to rationalize their relationship in the present time.

Course Contents

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), Factors affecting animal distribution. Barriers and dispersal. Zoogeographical regions (division, geographic ranges, physical features, climates, faunas and affinities of Holarctic (Palaearctic, Nearctic region), Oriental, Ethiopian, Australian, and Neotropical Region. Insular fauna; (Continental, Oceanic and Ancient Islands). Palaeogeography (Theories of Continental drift and Plate tectonics). Zoogeography of Pakistan: ecoregions, fauna of land and sea.

Practical

Study of distribution of mammalian and bird species using distributional range maps, visits of Natural History museums, National Parks, prominent ecological regions etc.

Recommended Books

1. Darlington, P.J. (1963). Zoogeography, the Geographical Distribution of Animals. John Wiley, N. Y.
2. Parker, Hesse, Allee and Schmidt. (1963). Ecological Animal Geography. John Wiley, N.Y.
3. DeBeaufort, L.F. (1951). Zoogeography of the Land and Inland Waters. Sidgwick and Jackson, London.
4. Ekman, S. (1967). Zoogeography of the Sea, Sidgwick and Jackson, London.
5. Jillies, (1974). Introduction to Zoogeography, London.
6. Muller, P. (1974). Aspects of Zoogeography. W. Junk Publishers, Hague.
7. Ali, S.S. Palaeontology, Zoogeography and Wildlife Management. 1999. Nasim Book Depot, Hyderabad, India.

ZOL-6302 REPRODUCTIVE PHYSIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of the subject is to learn about the essential reproductive, histology and physiology of reproductive organs and other relevant organs to integrate this knowledge to study processes that regulate metabolic processes in the body. In addition it includes the study processes of reproduction and examples of bodily dysfunction and disease that illustrate the basic principles of normal physiology through the absence of normal function.

Course Contents

Note: The emphasis shall be mainly on human being and poultry.

Cytological and genetic basis of sex. Female and male reproductive tracts, morphology and histology. Differentiation of sex and role of hormones. Gonadotropins, their chemistry and physiological characteristics. Mammalian ovary. Mammalian female reproductive cycles and its controlling mechanisms. Oogensis and Folliculogenesis. Brief study of avian ovary and its functional mechanisms. Mammalian testis. Spermatogenesis in man and domestic animals. Accessory sex organs in male mammals. Fertilization, early development, embryo transfer and implantation. Hormonal mechanisms in pregnancy, parturition. Mammary Gland development, milk synthesis and lactation. Nutrition and reproductive efficiency. Anti-fertillity mechanisms in human. Sterility causes in domestic animals.

Practicals

Study of male and female reproductive tracts in a mammal and a bird. Histology of different parts of the tract. Study of Spermatogenesis and folliculogenesis. Study of reproductive cycles in a mammal. Experiments on nutrition and reproductive efficiency in mammals and birds.

Recommended Books

1. Parkes, D.A. Marshalls, Physiology of Reproduction (Vol. I, II & III).
2. Young, W. C. Sex and Internal Secretion (Vol. I & II), Williams and Wilkins Co. London
3. Cole, H.H. and Cupps, P. T. (1977). Reproduction in Domestic Animals, Academic Press, New York.
4. Bearden H.J. and Fuquay, (1980). Applied Animal Reproduction, Reston Publishing Co. Inc. Reston.
5. Finn, C.A. (1979-81). Oxford. Review of Reproductive Biology (Vol. I, II & III), Clarendon Press, Oxford.
6. Hafez, E.S.E. (1982). Reproduction in Farm Animals, Lea and Febiger.

ZOL-6303 CLINICAL ENDOCRINOLOGY Cr. Hrs. 2+1

Aims and Objectives

To study that degeneration disease are the results of alterations in biochemical homeostasis regulated by endocrine system.

Course Contents

Functional pathology of Endocrine Glands: Neuroendocrine disorders of gonadotropin, prolactin, growth hormone, corticotrophin regulation; Pituitary disorders: Prolactinomas, Acromegaly, Cushing's syndrome. Diabetes insipidus, hypo- and hyper-tonic syndromes; Thyroid diseases of excess and deficient hormones and autoimmunity; Adrenal cortex: Disorders of cortical hypo and hyper-function; Disorders of Adrenal medullary function; Disorders of Ovarian function and hormonal therapy; Abnormalities of Testicular functions and hormonal therapy. Fuel homeostasis: Glucose homeostasis and Hypoglycemia; Diabetes mellitus; Disorders of lipoprotein metabolism; Eating disorders: Obesity, Anorexia nervosa and Bulimia nervosa. Development and Growth: Disorders of growth and puberty. Endocrine

Hypertension. Poly-endocrine Syndromes. Hormones and Cancer: Hormonal effect on Tumors, Breast and Prostate Cancer; Endocrine Therapy; Humoral Manifestation of Malignancy. Geriatric Endocrinology: Endocrine and associated metabolism in aging: specifically thyroid, glucose and calcium homeostasis.

Practicals

Studies of disorders of pituitary by observing anatomical and histological features. Studies of thyroid status in deficient and excess hormone functions; Studies of type 1 and type 2 diabetes mellitus: epidemiology of the types in population, studies of management of the type 2 diabetes mellitus. Model studies of disorders of Ovarian and Testicular disorders; Model studies of obesity and anorexia; Studies of status in puberty and aging.

Recommended Books

1. Greenspan, F.S. and Strewaler, G.J. 2002 Basic and Clinical endocrinology, 5th Edition. Prentice Hall International lnc. London.
2. Wilson, J.D., D.W., Kronenberg, H.M. and Larsen, P.R., 2008. Wlliams Textbook of endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
3. DeGroot, L.J., Jameson, J.L. 2001. Endocrinology, Vol. I, II & III, 4th edition. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., 2000. 4th Edition. Textbook of Endocrine Physiology. Oxford University Press, Oxford.
5. Neal, J.M., 2000. Basic Endocrinology: An Interactive Approach. Blackwell Science Inc. London.

ZOL-6304 NEUROPHYSIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course aims to understand the basic physiological mechanisms relating to the body coordination through cell membrane, nerve, muscle excitation and receptor function.

Course Contents

Foundation of excitability at cell membrane level: Membranes, channels and transport. The physical basis of neuronal function: Membrane excitation, resting and action potentials. Communication along and between neurons: Propagation of action potential, synaptic transmission, pre and postsynaptic mechanisms. Neurotransmitters: synthesis, release and their fate. Learning related changes at synapse. Neurochemical basis of behaviour. Organization of sensory receptors. Physiological basis of receptors functions: Mechanoreceptors, photoreceptors, chemoreceptors, Thermoreceptors, Electroreceptors and Nocireceptors.

Practicals

Experiments demonstrating: Nervous organizations in vertebrates (mammals), Potentials particularly the nerve impulse. Nervous regulation of functional system.

Recommended Books

1. Aidley, J. David, 1998. The Physiology of excitable cells. Cambridge University Press, Cambridge, U.K.
2. Ganong, W.F., 2000. Review of Medical Physiology. Prentice-Hall International Inc., London.
3. Randall, D., Burggren, W. And French, Kathleen, 1998. W.F. Freeman and Company, New York.

ZOL-6305 IMMUNOLOGY Cr. Hrs. 2+1

Aims and Objective

The aim of the course is to provide a greater understanding of the role of the immune system in preventing human disease and to focus on how deficiencies in immunity can result in disease susceptibility; in addition, students study the main subject areas in biosciences and medically related research; these subject areas include biochemistry, genetics, cell and molecular biology, anatomy and physiology as related to human health disease and treatment.

Course Contents

Cell mediated and humoral immunity, immunoglobulins, and the synthesis of antibody. Theories of antibodies synthesis. Antigenicity interaction of antigen and antibody. Hypersensitivity and its types with mechanism, classical and alternate compliment sequence, immunology in transplantation, autoimmunity to infections, immune deficiency diseases. Application of immunological phenomena in experimental biology.

Practicals

Antigens and elicitation of immune response. Experiments on methodology that employs immunological procedure such as radioimmuno assay.

Recommended Books

1. Roitt, M., (1979). Essential of Immunology, BlackWell, Oxford.
2. Benecerra, B. and Unanue, F.R. (1979). Text book of Immunology.
3. Bellanti, J.A. (1978). Immunology II, W. B. Saunders Company.
4. Fundehberg. H. Hstites, D.P., Classwel, J. B, and Wells J. O.V. (1980). Basic and Clinical Immunology, Lang Medical Los Angelos, California.
5. Hyde R., Hand Pathod, R.A., (1980). Immunology. Prentice Hall. Reston, Virginia.

ZOL-6306 HAEMATOLOGY Cr. Hrs. 2+1

Aims and Objectives

Hematology is the study of blood, blood forming tissues and organs, and blood disorders. The aims of the course are to import the knowledge and practice to the students to specialize them in the diagnosis, treatment, and prevention of blood disorders including anemia, blood clots, bleeding disorders, and blood cancers. As

blood runs through every organ and tissue in the body, hematology has an enormous ripple effect extending to all fields of medicine.

Course Contents

Introduction of blood, Constituents of blood, Function of the cellular elements of blood, Types of blood (Jaundic, Lipemic, Hemolytic, Anemic, Normal), Erythocytes, Erythopoiesis, Effect of erythropoietin, Erythroblastosis fetalis, Anemia (Nutritional anemia, Prernicious anemia, Aplastic anemia, Renal anemia, Hemorrhagic anemia, Hemolytic anemia, Sickle cell anemia, Hypochromic anemia). Types of Polycythemia (Primary polycythemia / polycythemia vera and Secondary/ Physiological polycythemia) Types of leucocytes, Types of lymphocytes, Typical human cell count, Blood cell production (Hemopoiesis), Plasma, Composition of plasma, Importance of blood group matching before blood transfusion, Factors involved in blood coagulation and clot lysis., Platelets, Formation of a platelet plug, Role of thrombin in hemostasis, Clot pathways, Anticoagulants, Types of hemophilia, Blood doping.

Practicals

Study of erythrocytes. Differential leukocytic counts in normal and immunized animals.

Recommended Books

1. Hoft Brand, A.V. And petit, Je. (1981). Essential of Hematology, Blackwell, Oxford.
2. Essential Haematology. Hoffbrand, A.V. and Hoffbrand,I.E. 2002. Peltit and PAH Moss
3. Haematology. Dacie and Lewis. 2002.

ZOL-6307 BIOTECHNOLOGY-I Cr. Hrs. 2+1

Aims and Objectives

Biotechnology is a science that uses the method and process for transformation of natural raw materials into useful product by the application of living organism in the industrial process. Thus, it is the biology in service to mankind. Main aims of biotechnology are: 1) To develop industrial processes for production of antibiotics, enzymes etc, 2) To develop gene surgery and gene therapy to cure genetic disease. 3) To create improved varieties of plants and animals through genetic engineering and plant breeding. 4) To develop techniques for tissue culture, cell culture and organ transplantation. 5) To develop bioenergy. 6) To develop biological processes of waste treatment to reduce the impact of pollution. 7) To develop biological process of plant disease control.

Course Contents

Restriction and modification system: Types, Enzyme, classification, Nomenclature, Genetics and applications. Cloning Vectors: Plasmids (Bacterial and yeast), Viruses (Ca, MV, SV40, BPV) phages (Lambda, Mu, M13). Cosmids and phagmids. Cutting and joining of DNA: Isolation and purification of DNA, Ligation of

DNA molecules, blunt ends and cohesive termini. Cloning Strategies; selection and characterization molecules, verification and amplification of desired genes, Gene Banks, PCR, RFLP, DNA sequencing techniques, DNA cloning, Southern blotting, Northern blotting, western blotting, site specific mutagenesis. Protein engineering. Applications of recombinant DNA technology with comprehensive theoretical know-how macromolecules of desired characters for transgenic.

Practicals

1. Isolation of plasmids and chromosomal DNA from bacteria and yeast.
2. Screening of bacteria for plasmids by electrophoresis of total cell lysate.
3. Gel electrophoresis of plasmids DNA chromosomal DNA & RNA.
4. Comparing plasmids of different molecular weights using Molecular Weights markers.

Recommended Books

1. Rehm, J.J. 1998. Fundamentals of Biotechnology, VCH Publishers, N.Y.
2. Lee, B.H. 1996. Fundamentals of Food Biotechnology, VCH Publishers, N.Y.
3. Pirt, J.B. 1975. Microbes and Cell Cultivation, Blackwell Scientific Publishers, London.
4. Bailey, J.E. and Ollis, D. F., 1986. Biochemical Engineering Fundamentals, McGraw Hills.
5. Watson, J.D., Tooze, J. and Kurta, D.T. 1983. Recombinant DNA-A short Course, Scientific American Books, New York.
6. Old, R.W. and Primrose, S.B. 1989. Principles of gene manipulation. 4th edition, Blackwell Scientific Publishers, London.
7. Molecular cloning, 1989. A Laboratory manual, 2nd edition, Cold spring Harbor Laboratory.
8. Higgins, I.J., Best, D.J. and Jones, J. 1988. Biotechnology Principles and Applications. Blackwell Scientific Publishers, London.
9. Rehm, J.J. 1988. Biotechnology: Special Microbial Process, Vol. 6 (b), VCH Publishers, N.Y.
10. Demain, A.L. and Solomon, N.A. 1986. Manual of Industrial Microbiology.
11. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic Engineering (4th Edition). Blackwell Scientific Publications. 1994.
12. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
13. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
14. Yount L., Genetic Engineering, Gale group, 2002.
15. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002
16. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001

ZOL-6308 BIOTECHNOLOGY-II Cr. Hrs. 2+1

Aims and Objectives

Industrial biotechnology (IB) is the use of biological resources (including plant, algae, marine life, fungi and micro-organisms) for producing and processing of materials, chemicals and energy. Microbes are also used to produce high level of industrial products through fermentation processes (e.g. brewing, bakery/industry) and enzyme engineering (as per securing vitamins, antibiotics and various biochemicals).

Course Contents

Application of biotechnology in industry; biotechnology of raw ore processing (bioleaching of sulphides, carbonates, silicates etc.) accumulation of metals by microbial cells, biopulping, biofuels, microbial enhanced oil recovery; application in agriculture, food and livestock products; biofertilization; production of cheese, probiotics, bread, single cell protein, citric acid, amino acid, acetic acid, production in drinks; microbial enzymes in industry, enzyme immobilization. Significance of Industrial Microbiology, Classification of microorganisms, fermentation principles, Culture techniques, Measurement and control of microbial processes, Introduction of probiotics. Introduction to industrial biotechnology, Biotechnology in textile, Chemical, Food, Pharmaceuticals, Agricultural industries, Industrial biocatalysts, Industrial waste, Industrial strain improvement, Screening for new metabolites, Recombinant DNA technology, Substrates for industrial fermentation, Regulation of primary and secondary metabolism, Design and development of industrial bioreactors, Problems and possibilities in fermentation scale up procedure, Bioreactors, Fermentors and controls, Bioenergy and Biofuels, Product recovery and refinement.

Practicals

Screening of enzymes of industrial significance, enzyme immobilization; Production of cheese, yogurt, citric acid, amino acid and acetic acid.

Recommended Books

1. Old R.W. and S. B. Primrose. Principles of Gene Manipulation, An introduction to Genetic Engineering (4th Edition). Blackwell Scientific Publications. 1994.
2. Setlow J. K., Genetic engineering; Principles and methods. Kluwer Academic Publishers 2000.
3. Nicholl. D. S.T., An introduction to Genetic Engineering, Cambridge University Press, 2000.
4. Yount L., Genetic Engineering, Gale group, 2002.
5. Sambrook J., D. W. Russell, J. Sambrook, Molecular Cloning: A laboratory Manual 93-Volume Set), Cold Spring Harbor Laboratory press, 2002.
6. Brown T.A., An introduction to Gene Cloning and DNA analysis: 4th Edition Blackwell Science Inc. 2001.

ZOL-6309 GENERAL TOXICOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course provides knowledge and understanding about the nature and mode of action of different categories of toxicants. This will be enabled to understand the differential effects of variety of toxicants on different cellular sites. They will also learn about the procedural protocols used in toxicological studies.

Course Contents

History and general introduction to Toxicology; Types of Toxicology; Specialized areas in Toxicology; Classification of Toxic chemicals; Types of Exposure and Exposure response including exposure characteristics; Spectrum of undesirable effects; Variation in toxic responses; Dose Response relationship; Acute lethality; Descriptive animal Toxicity Testing; Sub-acute, sub-chronic and chronic toxicity; Developmental/Reproductive toxicity; Mutagenicity; Absorption, Distribution and Excretion of toxicants; Biotransformation/Disposition of toxicants; Phase-I and Phase-II Biotransformation Reactions; Mechanism of Toxicity; Delivery, from the site of exposure to the target; Absorption versus pre-systemic elimination; Distribution to and away from the target; Excretion versus re-absorption; Toxication versus Detoxication; Toxicity resulting from Delivery; Reaction of the Ultimate Toxicant with the Target molecule; Attribution of Target Molecules; Effects of Toxicant on Target Molecules; Cellular dysfunction and resultant toxicities; Toxicant-induced cellular dysregulation; Toxic alterations of Cellular Maintenance; Repair and Dysrepair.

Practicals

1. Determination of LD50 values of some pesticide against any insect pest.
2. Determination of LD50 of any toxic compound in mammalian system.
3. Effect of any toxicant on body weight in mice.
4. Toxicity of some toxic compound on relative organ weight in mice.
5. Effect of toxicant on food consumption in mice.
6. Study of toxicity of any chemical on total leukocytes count.
7. Effect of toxicant on total erythrocyte count in blood of mice.
8. Effect of any toxicant on hemoglobin level in mice.
9. Study of inhibition of cholinesterase enzyme activity by organophosphate insecticides in mice.
10. Study of liver function enzyme (Alanine Aminotransferase) activity following administration of toxic compound to experimental animals.
11. Determination of blood glucose level following toxic exposure.

Recommended Books

1. Klaassen, Curtis D., (1996). Casarett and Doull's Toxicology; The Basic Science of Poisons; 5th Edition (International). McGraw-Hill, Health Professions Division, New York.
2. Timbrel, J. A. 1995. Introduction to Toxicology, 2nd Edition. Taylor and Francis Ltd. London.

ZOL-6310 HUMAN GENETICS Cr. Hrs. 2+1

Aims and Objectives

The course aims to help students learn to define basic genetics mechanisms in human inheritance to analyze inherited characteristics and diseases of human to understand genes, genomes, chromosomes and gene expression profiles with relations to phenotypic appearances, to use this knowledge for genetic research and counseling.

Course Contents

Introduction to basic concepts in genetics, brief overview of laws of inheritance, Patterns of transmission of single gene traits. Linkage and linkage maps, Genetic linkage with examples, normal chromosomes, Karyotyping. Pedigree analysis with criteria for identification of various modes of inheritance. brief description of cancer genetics, congenital malformations. Genetic defects in prenatal development; Introduction to human genome project.

Practicals:

1. Pedigree analysis.
2. Karyotyping of normal and abnormal human chromosomes.
3. Screening of metabolic and other disorders.
4. Problems solving on genetic counseling.
5. Orientation with different molecular techniques including PCR, RFLP

Recommended Books

1. Strachan, T., A. P. Read, Human Molecular Genetics, 3rd edition,Garland Science/Taylor & Francis. 2003.
2. Ehrlich P.R., Human Natures: Genes, Cultures, and the Human Prospect, 1st edition, Penguin USA Paper, 2002.
3. Relethford J. H., Genetics and the Search for Modern Human Origins, Wiley-Liss 2001.
4. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc. New York.2002.

ZOL-6311 GENERAL MICROBIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course is designed to enable the students to work with microorganisms. The basic techniques of sterilization, culturing, isolation and determining different characteristics of the microorganisms are included.

Course Contents

The beginnings of Microbiology: Discovery of the microbial world; The scope of microbiology. Microbial evolution, systematics and taxonomy; Characterization and identification of microorganisms. Nomenclature and Bergey's manual. Viruses: Bacteriophages and phages of other protests. Replication of bacteriophages. Viruses of animals and plants; History, structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses. Morphology and fine structure of bacteria, The Cultivation of Bacteria. Reproduction and growth of bacteria, quantitative measurement of bacterial growth. Pure cultures

and cultural characteristics. Eukaryotic Microorganisms: Algae: Lichens. Fungi, Protozoa. Prokaryotic diversity Bacteria, Prokaryotic Diversity: Archaea. Microbial Ecology: Microorganisms in nature, Microbial activity measurements, Aquatic habitats, Deep-sea microbiology, Terrestrial environments, Hydrothermal vents, Rumen microbial ecosystem, Microbial leaching, Biogeochemical cycles; Trace metals and mercury, Biodegradation of Xenobiotics.

Practicals

The culture of microorganisms: preparation and sterilization of culture media, broth culture, agar slope, agar slab, streak plates, pour plates. Isolation of a bacterial culture, Quantitative plating methods. The turbidimetric estimation of microbial growth.

Recommended Books

1. Pelczar Jr., Chan, E.C.S. and kreig, M.R. (1986). Microbiology, McGraw Hill, London.
2. Peltler, G.L.A Laboratory Manual of Microbiology.
3. Benson, H.J. Microbial Applications: Laboratory Manual In General Microbiology, 1994. WMC Brown Publishers, England.
4. Madigan, M.T., Martinko, J.M. and Parker, J. Brock Biology of Microorganisms, 1997. Prentice-Hall, London.

ZOL-6312 GENERAL PARASITOLOGY Cr. Hrs. 2+1

Aims and Objectives

This course aims to provide knowledge regarding different modes of transmission of parasites of medical and veterinary importance along with their pathology, host parasite relationship and control measure. The goals of the course are to equip students with a fundamental understanding of parasitology science and competence in relevant recent parasitological techniques.

Course Contents

Principles of Parasitology. Various concepts of Parasitism. Systematics, biology, pathology and control of protozoan and helminthes parasites of medical and veterinary importance. Ecology of parasites. Host-parasite relationship. Parasitic zoonoses. Immunity and resistance.

Practicals

Preparation of temporary and permanent slides and identification of parasitic protozoan and local helminthes of medical and veterinary importance. Section cutting of the infected tissues and the study of their pathology.

Recommended Books

1. Robberts, L. Sand Janovy John Jr. (2009). Foundation of Parasitology. 8th edition. McGraw Hill, Boston
2. Chandrasoma , P. and Taylor, C.R.(1997). Concise Pathology. Prentice Hali International Inc. New Jercy USA.

3. Facust, E. C. and Russell, P. F. (2001). Craig and Faust's clinical Parasitology. Lea and Febiger, 8th edition London
4. Markell, E.K. Mo. Vogo. (1999). Medical Parasitology. W. B. Sundress Co: Philadelphia.
5. Olsen, O. W. (1986). Animal Parasites: their life cycle and ecology. University Park Press Baltimore
6. Peters, W and Gills, H.M. (1989). A color atlas of Tropical medicine and Parasitology. Wolfe Medical Publications Ltd., Netherlands.
7. Robbins, S. L. Basic Pathology. W. B. Saunders Co: London, Toronto.
8. Soulsby: E. J. L. (1981). Textbook of veterinary clinical Parasitology Vol: 1 Blackwell Scientific Publication, London.
9. Smyth, J. D. (1994). Introduction to Animal Parasitology, 3rd edition. Cambridge University Press, Cambridge.
10. Walter, J.B. and Israel, M.S. (1979). General Pathology . Charchill Living Stone Edinburgh , London and New York.

ZOL-6313 INVERTEBRATA Cr. Hrs. 2+1

Aims and Objectives

The course is designed to provide students with the concepts of structure, classification biology and evolutionary relationship of invertebrate phyla.

Course Contents

Structure, classification and biology of Protozoa, Mesozoa, Coelenterata, Cenliophora, Platyhelminthes, Nematoda, Rotifera, Annelida, Echiurida, Sipunculida, Bryozoa, Branchiopoda, Mollusca and Echinodermata.

Practicals

Preparations of slides, Daphnia, Cyclops, Housefly, Mosquito, Mouth parts of cockroach and butterfly, Honey bee, Museum study of prepared slides.

Recommended Books

1. Parker and Haswell. A Text Book of Zoology (Vol .1) McMillan. London
2. Barrington, E.J.W., (1969) Invertebrates structure and function, the English Language book society, London.
3. Henger and Engelmann. Invertebrate Zoology.
4. Borradial, L.D., (1963). The Invertebrata Cambridge university press
5. Hyman, L.H. (1940). Invertebrates (Vol 1.VI). McGraw-Hill, New York.

ZOL-6314 GENERAL ENTOMOLOGY Cr. Hrs. 2+1

Aims and Objectives

The students will learn to identify the pest during damaging to the crop; Students will understand methods of population estimation of the pest and application of different control strategies.

Course Contents

Introduction, Phylum Arthropoda and its classification; external and internal morphology and physiology with particular reference to a typical insect; metamorphosis and its types; insect classification, salient characters of insect orders and families of economic importance with examples of each family.

Practicals

Characters of classes of Arthropoda; collection, identification and preservation of insects; external and internal morphology of typical insects; temporary mounts of different types of appendages of insects; types of metamorphosis

Recommended Books

1. Elzinga, R. T. 2003. Fundamentals Of Entomology. Prentice Hall.
2. Gullan, P.I. & P. S. Crauston, 1994. The Insects (An Outline Of Entomology) Chapman & Hall New York.
3. Jhonson, N.F., Triplehorn, C.A. Borror And Delong's, 2004. Introduction To The Study Of Insects. Brooks Cole. 7th Edition.
4. Lohar, M.K. 1998. Introductory Entomology, Kashif Publications, Hyderabad, Pakistan.
5. Main, M.S., 1990. General Entomology (4th Ed). Oxford & IBH Publishing Co. Pvt. Ld. New Delhi.
6. Richards, O.W. And R. G. Davies, 1984. Imm's General Text-Book Of Entomology, Vol. I. And II, 10th Ed. Chapman & Hall, London, N.Y.
7. Shahid, M. 1984. Lab Mannual Of General Entomology. National Book Foundation, Paksitan.
8. Tonap, G. T., 1994. Experimental Entomology, An Aid To Laboratory And Field Studies. C.B.S. Publishers And Distributors Delhi.
9. Chapman, R.F. The Insects: Structure And Function, 2000. Blackwell Science Inc., London.
10. Krebs, C. J. Ecology: The Experimental Analysis Abundance. 5th Edition. 2000. Benjamin-Cummings Publishing Company.
11. Tembhare, DB. Modern Entomology. 2002. Himalaya Publishing House, India.

ZOL-6315 PRINCIPLES OF FISH BIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to enable students in obtaining complete understanding about freshwater as well as marine fishes in general and freshwater culturable fishes in particular. It comprises morphology, anatomy, classification and some understanding about various feeding groups found in different water bodies. After having complete knowledge of above, students will be able to practice independently.

Course Contents

Fish Morphology: Head (Size, shape, and orientation), Scales (types, arrangements, coloration, scaleless fishes), Operculum, fins, fin rays and fin spine (Dorsal, pectoral, caudal, anal), Barbel (upper lip barbels, lower barbels). Anatomy: Skeleton (skull, backbone, spines), Brain and spinal cord, Gills (No, size, arrangements), Vital organs (heart, liver, kidney), Viscera and mesenteries. Swim bladder, stomach, spleen, pancreas, intestine, glands. Systematic: Identification of fishes up to; families, Order, Genus and Species, Feeding groups of fishes, herbivore, Plankton eater, Larvivore, Carnivore, Voracious. Ecology of fishes: Freshwater, Brackish water, Marine.

Practicals

1. Collection, Preservation and identification of freshwater fish species.
2. Study of different organs of various fish species
3. Study and survey of various fish collection present in museum like Natural History Museum at Islamabad, G.C. Lahore & at P.U. Lahore.

Recommended Books

1. Kestin Farmed Fish Quality (2001).
2. Woo. Fish diseases and Disorder: *Protozoan and Metazoan infections* (1995)
3. Brenabe Aquaculture Vol. I&II (1992) Fishing News Books Ltd. England
4. Maseke C. Aquaculture, I&II (1992) Pergamon Press, Oxford.
5. Huet M. Text Book of Fish Culture: *Breeding and cultivation* Fishing News Book Ltd. England.
6. Kestin, S. C. and Warris, P.D. (Edition). Kestin Farmed Fish Quality, 2002, Blackwell Science, Oxford, UK.

ZOL-6316 FISHERIES AND AQUACULTURE Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide knowledge about different requirements for the culture of different cultivable aquatic species. The subject provides practicals information to obtain better growth by following physiological aspects during extensive or semi-intensive culture. It also emphasizes thoroughly in breeding and diseases of most culturable freshwater fishes and prawns.

Course Contents

Basic principles of Aquaculture (fish and prawn). Natural food and feeding. Growth and breeding of the important culturable prawns and fishes. Diseases and their control.

Practicals

Study of the gut contents of important fishes. Study of the major parasites of fish. Study of early developmental stages of fishes. Methods of induced spawning.

Recommended Books

1. Auet, M. (1972). Textbook of Fish Culture, Breeding and Cultivation of Fish.
2. Various publications of the Directorate of Fisheries on fish-farming etc.
3. Brenabe, G. AQUACULTURE, Vol. I. 1992 Blackwell Publishing, Oxford. UK.
4. Maseke C. FISH AQUACULTURE. 1987. Pergamon Press, Oxford. UK.

ZOL-6317 LIMNOLOGY-A Cr. Hrs. 2+1

Aims and Objectives

To provide information about inland waters, biological productivity and to minimize the pollution of inland water for better aquaculture production. The student will be able to learn about physical and chemical properties of water in order to increase biological production.

Course Contents

Definition, Importance, Inland waters, Sources of bottom materials, Physical features of water, temperature, light, currents, density and water turbidity. Chemical features of water dissolved gasses, dissolved solids, pH, Electrolytes alkalinity, hardness, salinity, brief description of nitrogen and phosphorous cycles.

Practicals

Survey of major water bodies in Azad Kashmir & Pakistan (lotic and lentic waters). Morphometric analysis of rain water, stream water, lake water, pond water and ground water. Preliminary general tests, odour, colour, dissolved gases, dissolved solids, suspended solids, pH, alkalinity, salinity, hardness, micronutrients.

Recommended Books

1. Goldman, C.R. and Horne, A.J. 1983. Limnology. McGraw Hill, International Book Company, Japan.
2. Welch, P.S. 1968. Limnology, 4th Edition, McGraw Hill book. Inc. New York.
3. Allen S. E. 1990. Chemical Analysis of Ecological Materials, Scientific Publishers, London.
4. Robert G. Wetzel. 1983. 2nd Edition. Limnology. Saunder Publishers, New York.
5. Gerald A. Cole. 1983. 3rd Edition. A Text Book of Limnology. Waveland Press Inc. USA.

ZOL-6318 PRINCIPLES OF HERPETOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide knowledge about the classification, population and distribution of Amphibians and Reptiles with reference to their ecological adaptations and interactions.

Course Contents

Classification of amphibians and reptiles. Evolution, geographical distribution, population biology of reptiles and amphibians. Biology, including anatomical, physiological adaptations to their environment, reproduction, foods/feeds, communication (vocal, chemical, behavioural). Mechanism of hibernation in herpeto-fauna (effect of climatic factors). Poisonous species. Sensory mechanisms, predator-prey relationships, chemistry and physiological actions of venoms and patho-physiology and treatment of snake bite.

Practicals

1. Visit of PMNH for study of preserved specimens of herpeto-fauna in relation to their taxonomy and ecosystem.
2. Field visits of different habitats for direct/indirect observations of amphibians and reptiles with respect to their ecologies and weather conditions.
3. Visit to Zoos and wildlife parks.

Recommended Books

1. Daniel, J.C. 1992. The Book of Indian Reptiles . Bombay Natural History Society, India.
2. Girard, C. 1978. Herpetology. Arno Press.
3. Pough, F. H. 2001. Herpetology. Prentice Hall.
4. Zug, G. R. 1993. Herpetology: An introductory biology of Amphibian and Reptiles. Academic Press.
5. Khan, M.S. 2006. Amphibians and reptiles of Pakistan. Krieger Publishing Company, Florida, USA. 311 pp.

ZOL-6319 BIODIVERSITY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide basic knowledge to students about the basic concepts of biological diversity, threats to biodiversity and its management. Also to provide knowledge about the threatened species of wild animals and their management principles and efforts being made at global and national level.

Course Contents

Definition, Types; Levels; Status of Biodiversity; Biodiversity resources of Pakistan including AJ&K. Importance of Biodiversity. Major threats and causes of loss of biodiversity, Conservation of biodiversity. In-situ & ex-situ conservation of biodiversity, Protected areas concept. Pakistan and IUCN PAs categories, Ramsar sites, Biodiversity Action Plan for Pakistan. biotechnological intervention in biodiversity conservation, International laws/conventions (CBD, CMS, CITES, Ramsar, etc.) regarding biodiversity conservation and their implementation in Pakistan.

Practicals

1. Procedures for studying biodiversity, species richness, Simpson Index, Shannon and Weiner Function.
2. Bird’s population Census Techniques.

3. Mammal's population Census Techniques.

Recommended Books

1. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing & Co. London, UK.
2. K. V. Krishnamurthy, 2003. Text Book of Biodiversity, Science Publisher USA
3. B.N. Pandey, A.P. Sharma, P.N. Pandey, P.K. Katiha and K. Jaiswal (editors), 2012. Biodiversity: Issues Threats and Conservation: Narendra Publishing House.
4. Kumar & Asija, 2000. Biodiversity, Principles and Conservation.
5. Mary Jenking and Ann Boyce, 1987. The Diversity of Life.
6. R. Rehmani and Salim Ali: Birds Censing Techniques.
7. Roberts, T. J. The Birds of Pakistan, (Vol. II), 1992. Oxford University Press.
8. Roberts, T. J. The Mammals of Pakistan, 1997. Oxford University Press.
9. Mirza, Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
10. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 4th ed. John Wiley & Sons, Inc.
11. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
12. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition).McGraw Hill, New York.
13. Ali, S.S. Paleontology, Zoogeography & Wild-Life Management. 1999. Nasim Book Deptt. Hyderabad, India.
14. UNEP. 2005. Selected texts of legal instruments in international environmental law. United Nations Environment Program. Nairobi. Kenya.734.

ZOL-6320 HISTOLOGY Cr. Hrs. 2+1

Aims and Objectives

The fundamental aim of histology is to determine how tissues are organized at all structural levels, from cells and intercellular substances to organs.

Course Contents

Brief introduction to cells and tissues, study of epithelial tissues, connective tissues, blood cells, lymphatic tissues and the immune system, bone and cartilage, joints, muscles. Anatomy of heart, lungs, liver, kidney, spleen, digestive tract, brain, skin and endocrine glands and reproductive tract with histopathological aspects.

Practicals

Preparation and study of stained slides of different tissues of animals

Recommended Books

1. Eroschenko, Victor, P. (2008). Difioe's Atlas of Histology with Functional Correlations 11th Edition. Wolters Kluwer health (India) Pvt. Ltd. New Delhi.

2. Luiz Carlos Junqueira and Jose Carneiro (2005). Basic Histology Text and Atlas 11th Edition. McGraw Hill Medical Publishing Division New York.
3. Mills, Stacey, E. (2007). Histology for Pathologists 3rd Edition. Lippincott Williams and Wilkins a Wolters Kluwe Business Philadelphia.
4. Ham, Arthur W., Cormack, David, H (1987). Ham's Histology 9th Edition. J.B. Lippincott Company, Phlladelphla. London.
5. Arthur Smith & John Bruton (1977). A Colour atlas of Histlogical Staining Techniques. Wolfe Medical Publication Ltd. London WC2.
6. Copenhaver, Wilred M., & Kelly, Douglas E., & Wood, Richard, L (1978). The Williams and Wilkins Company/Baltimore Tokyo.
7. M. Ahsan Karim, & Khalid M. Khan, (1986). A Guide Histology Practical. Feroz Sons Lahore Pakistan.
8. Ham, Arthur W., (1969). Histology 6th Edition. J.B. Lippincott Company Philadelphia Toronto.

ZOL-6321 BIOLOGICAL TECHNIQUES Cr. Hrs. 1+2

Aims and Objectives

1. To make aware of the basic philosophy of science, its history, concepts and scope
2. To develop proper scientific mind, culture and work habits
3. To familiarize with the basic tools and techniques of scientific study with emphasis on biological sciences
4. Basic understanding on principle and uses of the following:

Course Contents (theory and practicals)

Microscopy: Principles of light microscopy. Magnification, Resolution, Contrast. Types of microscopy, Bright field (Compound Microscope), Scanning microscopy, Eyepiece micrometers, Camera Lucida Phase Contrast Dark field Interference microscope, Electron microscope. **Micrometery and Morphometry**: Use of stage and ocular micrometer. Calibration of ocular micrometer. Size measurement (length, width, diameter). **Standard system for weight, length, volume :** Calculations and related conversions of each:- Metric system- length; surface; weight - Square measures- Cubic measures (volumetric)- Circular or angular measure- Concentrations- percent volume; ppt; ppm - Chemical molarity, normality - Temperature- Celsius, centigrade, Fahrenheit. Preparation of stock solutions of various strengths. **Specimen preparation for optical microscopy**: **Microtomy:** Fixation, embedding, Section cutting (transverse, longitudinal section, mounting and staining. Sections in paraffin and cryosections. **Extraction techniques:** Centrifugation, Ultra centrifugation, cell fractionation, filtration, Distillation, Use of Soxhalet and Rotary evaporator for extraction. **Separation Techniques:** Chromatography: Principle, applications, types, thin layer, paper, column, gas, ion exchange chromatography. Electrophoresis: Principle, applications, types. **Spectrophotometery:** Principle, applications, types, visible spectrum, UV spectrum, atomic absorption. **Basic principles of Sampling and Preservation:** Sampling soil organisms, Invertebrates, Aquatic animals, Mammals, Estimation of population size,

Preservation of dry and wet specimens. Preservation techniques – Taxidermy - Rearing techniques, Laboratory and field.

Recommended Books

1. Dean, J. R. Extraction methods for environmental analysis. 1999. John Wiley And Sons Ltd. UK.
2. Curos, M. Environmental sampling and analysis: Lab Manual. 1997. CRC Press Lic. USA. 38
3. Curos, M. Environmental sampling and analysis: For Technician. 1997. CRC Press LLC. USA.
4. Cheesbrough, M. District laboratory practice in tropical countries. Part i. 1998. University Press Cambridge, UK.
5. Cheesbrough, M. District laboratory practice in tropical countries. Part ii. 1998. University Press Cambridge, UK.
6. Slingsby, D. and Cock, C. Practical ecology. 1986. Mcmillan Education Ltd. London.

ZOL-6322 RESEARCH METHODOLOGY Cr. Hrs. 2+1

Aims and Objectives

The main objectives of this paper are to introduce student to the basics of research and research design in biology and to prepare them to develop and design their own research works, formulate their research manuscripts etc.

Course Contents

Introduction: Meaning of research, objectives and significance of research, research processes, criteria for good research, problems encountered by researchers in Pakistan. **Defining research problem:** Selecting research problem, techniques involved in defining a problem. Developing hypothesis. **Review of literature:** Different forms and sources of acceptable data and techniques of acquiring required literature. **Research and sampling design:** Need for research design, characteristics of a good research design, basic principles of experimental designs, Steps in sampling designs, different types of sampling designs, developing a research proposal/ plan. **Data collection:** types of data, methods of data collection, processing and analysis of data, **Writing of Research Thesis/Report and Research Paper:** (composition, arrangement and formatting); Publication of research work, finding of suitable journal, formatting and submitting of manuscript, Ethical, legal, social and scientific issues in Biological Research. Plagiarism. **Introduction to scientific research projects/funding:** Finding financial support and industry partnership. A brief idea about the funding agencies such as HEC, PSF, EU, USAID. etc.

Practical

Designing and developing case studies. Practice of Review of literature from different sources. Practice of writing scientific papers/ projects.

Recommended Books

1. Michael P. Marder, 2011. Research Methods for Science. Cambridge University Press
2. Thomas E. Ogden, Israel A. Goldberg, 2002. Academic Press USA
3. C.R.Kottari. 1990. Research Methodology: Methods and Techniques (2nd Ed.) Ram Printograph. Delhi
4. Robert, A. Day. 1989. How to write and publish a scientific research paper. 3rd Edition.
5. Holmann, H.H. 1962. Biological research method. Olvyer and Boyd Ltd.

LIST AND COURSE CONTENTS OF ELECTIVE/OPTIONAL/SPECIAL COURSES FOR M. SC. PROGRAM IN ZOOLOGY 4TH SEMESTER

SEMESTER-IV (Cr. 15)

Course code	Course title	Credits	Status
ZOL-64**	Elective-I	2+1	
ZOL-64**	Elective-II	2+1	
ZOL-64**	Elective-III	2+1	
ZOL-64**	Elective-IV	2+1	
ZOL-64**	Elective-V	2+1	
ZOL-6423	Comprehensive Oral Examination	S/U	Compulsory
ZOL-6424	Thesis (Research Project)	0+6	
Note: students who opt special papers in lieu of Research will have to opt four elective papers from the field of specialization while research students will opt two elective papers which will be closely related to their field of research.			
	Total Credits	**15**	

LIST OF ELECTIVE COURSES FOR M. SC. PROGRAM IN ZOOLOGY

SEMESTER-IV

Course Code	Course Title	Lec. Hrs	Lab. Hrs.	Credit Hrs.
ZOL-6401	Physiological Systems and Adaptations	2	1	3
ZOL-6402	Molecular Physiology	2	1	3
ZOL-6403	Endocrinology	2	1	3
ZOL-6404	Animal Behaviour	2	1	3
ZOL-6405	Economic Zoology	2	1	3
ZOL-6406	Bioremediation & Environmental Biotechnology	2	1	3
ZOL-6407	Biochemistry – II	2	1	3
ZOL-6408	Molecular Biology	2	1	3
ZOL-6409	Medical Microbiology	2	1	3
ZOL-6410	Applied Microbiology	2	1	3
ZOL-6411	Medical Parasitology	2	1	3
ZOL-6412	Helminthology	2	1	3
ZOL-6413	Vector Biology	2	1	3
ZOL-6414	Animal Pests and Disease Producing Organisms	2	1	3
ZOL-6415	Fish Physiology	2	1	3
ZOL-6416	Ichthyology (Fish Morphology)	2	1	3
ZOL-6417	Limnology-B	2	1	3
ZOL-6418	Vertebrata	2	1	3
ZOL-6419	Ornithology	2	1	3
ZOL-6420	Mammalogy	2	1	3
ZOL-6421	Wildlife	2	1	3
ZOL-6422	Environmental Issues	2	1	3

ZOL-6423	Comprehensive Written Examination	S/U Basis		
ZOL-6424	Thesis	0	0	6

CONTENTS OF ELECTIVE COURSES FOR M. SC.IN ZOOLOGY

4TH SEMESTER

ZOL-6401 PHYSIOLOGICAL SYSTEMS AND ADAPTATIONS Cr. Hrs. 2+1

Aims and Objectives

The course aims to understand the basic physiological mechanisms relating to different body organs and systems and their relationship with the surrounding environment.

Course Contents

Cardiovascular System: Blood and homeostasis; Physiology of cardiac muscles; Automaticity and rhythmicity in heart activity and electrocardiography; Regulation of heart activity; Hemodynamics; Arterial system; cerebral, fetal. **Respiratory System:** Overview of respiratory system; Pulmonary and bronchial circulations; Mechanical aspects of breathing; Transport of oxygen and carbon dioxide; Regulation of ventilation; Respiratory responses in extreme conditions. **Renal System:** Elements of renal function; tubular function in nephron; Control of body fluid volume and osmolality; Potassium, Calcium and Phosphate homeostasis; Role of kidney in acid-base balance. **Gastrointestinal System:** Gastrointestinal secretions and their control: salivary, gastric, pancreatic and hepatic; Digestion and absorption of carbohydrates, proteins, lipids, vitamins, ions and water; Motility of gastrointestinal tract: Functional anatomy, regulation and motility in various segments. **Osmoregulation:** Problems of osmoregulation; Obligatory exchange of ions and water; Osmoregulators and osmoconformers; Osmoregulation in aqueous and terrestrial environments. **Environmental Challenges:** Temperature and animal energetics; Temperature relation of ectotherms, Heterotherms and endotherms; Dormancy: Special metabolic state; body rhythms and energetic; Energy, environment and evolution.

Practicals

Experiments on the study of heart in prepared frogs; Study of blood pressure in various physiological states; Study of electrocardiograms; Blood coagulation study. Determination of oxygen consumption in fish and mouse and effects of different factors; Demonstration of respiratory volume and pulmonary function tests. Experiments on digestion of nutrients by enzymes and effects of factors; study of exocrine secretion in stomach and pancreas. Experiments on kidney regulation of osmolarity; Urine analysis; Study of osmoregulatory adaptations in animals inhabiting various environments; Demonstration of effect of temperature on several physiological responses; Study of animals in various types of dormancy.

Recommended Books

1. 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
2. Bullock, J., Boyle, J. and Wang, M.B., 2001. Physiology, 8th ed. Lippincott, Williams and Wilkins, Philadephia.
3. Berne, R.M. and Loevy, M.N., 2000. Principles of Physiology, 3rd edition. St. Lious, Mosby.
4. Guyton, A.C. and Hall, J.E. 2000. Textbook of Medical Physiology, 10th Edition. W.B. Saunders Company, Philadelphia.
5. Withers, P.C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environments, 5th edition. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D. 2002. Experiments in Physiology, 8th Edition. Prentice Hall, London.

ZOL-6402 MOLECULAR PHYSIOLOGY Cr. Hrs. 2+1

Aims and objectives

1. To understand physiological mechanism at molecular level.
2. To correlate molecular mechanisms at organs and organism level.

Course Contents

Overview of resting membrane potential, action potential and synaptic transmission; Structure and mechanisms of ion channels; Biosynthesis of neurotransmitters; Neurotranmitters actions at synaptic receptors. Neurosecretions and neurotransmitters in higher nervous system activity. Molecular mechanisms in transduction of sensory stimuli into impulse; photochemistry and transduction of photoreceptor; Colour vision. Overview of endocrine glands, their hormones and roles; Chemistry and biosynthesis of hormones of adenohypophysis, thyroid, parathyroid, endocrine pancreas, adrenal medulla and steriodogenic tissues; Metabolism of thyroid and steriodogenic tissues; structure of hormone receptors; Mechanisms of action of a protein/peptide, a steroid and thyroid hormone; Hormonal regulation of metabolism; Molecular basis of muscular contraction; Molecular interaction at neuromuscular level; Molecular structure of cilia and flagella and mechanisms in movements. Exchange of respiratory gases; Chemical regulation of respiration. Nature and formation of various nitrogenous waste products; Glomerular filtration, reabsorption and secretion mechanisms; Concentration of urine. Regulation of digestive secretions; Digestion and absorption of nutrients. Molecular mechanisms in adaptation to temperature extremes.

Practicals

Study of post-synaptic receptor mechanisms in neuromuscular preparation of frogs; Experiments to study the molecular responses to hormones. Study of hormones receptors in different hormonal circulation levels; Ultra-structure study of muscle structure for muscle contraction. Effect of chemicals and drugs on cardiac

activity of prepared frogs; study of drugs on reflexes and local circulation models. Respiratory function and oxygen consumption in acidosis and alkalosis in mouse. Study of nature of nitrogenous wastes of animals inhabiting different environment. Urine analysis in different physiological states. Absorption of glucose in inverted intestinal sac, effect of drugs on intestinal movements. Muscular responses to pyrexia.

Recommended Books

1. Randall, D., Burggren, W., French, K. and Fernald, R., 2002. Eckert Animal Physiology: Mechanisms and Adaptations, 5th ed. W.H. Freeman and Company,
2. Bullock, J., Boyle J. and Wang, M.B., 2001. Physiology 8th edition. Lippincott, Williams and Wilkins, Philadelphia.
3. Berne, R.M. and Levy, M.N., 2000. Principles of Physiology, 3rd edition. St. Lious, Mos by.
4. Guyton, A.C. and Hall, J.E., 2000. Textbook of Medical Physiology, 10th Edition. W.B. Saunders Company, Philadelphia.
5. Withers, P. C., 1992. Comparative Animal Physiology. Saunders College Publishing, Philadelphia.
6. Schmidt-Nelsen, K., 1997. Animal Physiology, Adaptation and Environments, 5th edition. Cambridge University Press, Cambridge.
7. Tharp, G. and Woodman, D., 2002. Experiments in Physiology, 8th Edition. Prentice Hall, London.

ZOL-6403 ENDOCRINOLOGY Cr. Hrs. 2+1

Aims and Objectives

4. General concepts and principles of chemical coordination.
5. The details of the endocrine mechanisms in relation to various functions such as reproduction and lactation.
6. Recent trends of endocrinology in relation to diversified function.

Course Contents

Introduction Endocrinology, Vertebrate Endocrine System. Mechanism of Hormone Action Endocrine Methodologies, Pituitary Hormones, the Endocrine Hypothalamus, Neurohypophysial Hormones, Opiomelanocortins, Hormonal control of Calcium Homeostasis, GIT hormones, Pancreatic hormones and metabolic regulation, Growth hormones, Thyroid hormones, Catechoalmines and sympathoadrenergic system, Adrenal steroid hormones, Endocrinology of sex differentiation and development, Hormones of male reproductive physiology, Hormones of female reproductive physiology, Endocrinology of Pregnancy, Parturition and Lactation, Endocrinology of Pineal Gland. Pathophsiology of hormones.

Praticals

Gross and histological structure of endocrine glands. Techniques of ansthesia and surgery. Studies in physiological effects of hormones.

Recommended Books

1. Greenspan, F.S. and Strewler, G.J. (2002). Basic and clinical endocrinology. 5th Edition. Prentice Hall International Inc., London.
2. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P.R. (1998). Williams Textbook of Endocrinology, 9th Edition. W.D. Saunders Company, Philadelphia.
3. L.J., Jameson, J.L. et al. (2001). Endocrinology. DeGroot Vol.I, II, III, 4th ed. W.B. Saunders, Philadelphia.
4. Giffin, J.E. and Ojeda, S.R., (2000). Textbook of Endocrine Physiology. 4th Edition. Oxford University Press, Oxford.
5. Neal, J.M., (2000). Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.
6. Turner, C.D. and Bagnara, J.T. (1976). General Endocrinology, W.B, Saunder London.
7. Barrington, E.J.W. (1963). An introduction to General and Comperative Endocrinology, Calrendom Press.
8. Bently, P.I. (1982). Comparative Vertebrate Endocrinology, Cambridge University Press Cambridge.
9. Wilson, J.D. and Foster D.W. (1985). Text Book of Endocrinology. W.B Saundres, Philadeliphia.

ZOL-6404 ANIMAL BEHAVIOUR Cr. Hrs. 2+1

Aims and Objectives

To teach students:

1. The concept of physiological mechanism.
2. Functional aspects in animal life
3. The designs of mechanisms in nervous and hormonal coordination, muscle and movements, respiratory gas exchange, excretion and osmoregulation, nutrition and thermal regulation.
4. To correlate these mechanisms at biochemical, molecular and cellular levels to the functions at organ system and organism level.
5. Physiological mechanisms in manifestation of behaviour.

Course Contents

Introduction: History of animal behaviour. Approaches and methods. Mechanisms of behaviour: The nervous system and behaviour. Hormones and behaviour Immunology and behaviour. Biological rhythms. Development of

behaviour. Learning behaviour. Communication. Finding Food and shelter: Migration, Orientation and navigation. Habitat selection. Foraging behaviour. Social Organization and Mating systems: Conflict. Sexual reproduction and parental care. Mating systems and parental Care. Social systems.

Practicals

Experiments on reflexes, latency, after-discharge, summation, warm up, fatigue, inhibition and feedback. Experiments on habituation, conditioned reflex type I and trial and error learning. Experiments showing hormonal involvement in behavioural responses. Study of social integration in social insects. Study of hibernation and biological rhythms.

Recommended Books

1. Drickamer, L. C., Vessey, S. H. and Jacob, E. 2002. Animal behaviour: Mechanism, Ecology Evolution. 5th Edition.
2. Manning, A. and Dawkins, M. S. 1997. An introduction to animal behaviour, 8th edition. Cambridge University Press, Cambridge.
3. Tonap, G. T. 1998. Experimental Entomology an Aid to Laboratory and Field Studies. C. B. S. Publishers Delhi.

ZOL-6405 ECONOMIC ZOOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course provides the basic knowledge about the economic importance of various species of animal kingdom. It provides knowledge about the delitarious effects of different species (e.g., parasites) on human society and also provides the basic knowledge on the positive aspects of different animal species.

Course Contents (Theory and Practicals)

Parasitic protozoa and diseases. Phytoparasitic, Nematodes and their control. Helminthes Parasites of man and other domestic animals and their control. Mites and ticks and their control. Households insects. Insects of cash crops. Apiculture, Lac-culture, Sericulture and fisheries in Pakistan. Aquaculture value added by products of fishing industry. Poultry economic importance of mammals. Genetic improvement of animal. Leather industry. Wool industry. Pharmaceuticals from animals. Bioactive substances from animals, Rats and their control. Resource survey and management

Recommended Books

1. Shukla, G.S. Economic Zoology.
2. Vishwaprem, K. K. C. Economic Zoology.
3. Jawaid Ahsan, Subhas Prasad Sinha. A Hand Book On Economic Zoology.
4. Shukla & Upadhyaya. 2009. Economic Zoology 4th ed. Rastogi Publications.
5. Mathur S., 2009. Economic Zoology Biostatistics and Animal Behaviour. Rajpal and Sons Publishing.

ZOL-6406 BIOREMEDIATION & ENVIRONMENTAL BIOTECHNOLOGY Cr. Hrs. 2+1

Aims and Objectives

Biodegradation of various pollutants and also acts as the microbial metabolism to remove pollutants. The purpose of environmental and bioremediation is used to study harmul substances which are contaminating the environment and discovering and inventing such processes which can be beneficial for the environment.

Course Contents

Concept of bioremediation; Bioremediation of heavy metals, xenobiotic compounds and hazardous wastes; techniques used in bioremediation, bioremediation through consortia of microbes and invertebrates; renewable and non-renewable resources; bioleaching and biomining (low grade and sulfide containing ores processing); domestic solid waste and management. Waste water, sludge and sewage management; biological methods of wastes treatment; sample collection and preservation; bioremediation of crude and petroleum oils. Role of yeast in bioremediation. Biological fuel generation; Bioremediations of industrial effluents.

Practicals

Bioremediation of heavy metals through invertebrates, consortia of microorganism, mycoremediation.

Recommended Books

1. Environmental Science (Earth as a living planet). 2000. 1st ed. Botkin, D. and Keller, E. John Wiley and Sons Inc. New York, USA.
2. Practical Environmental bioremediation the field guide, 1977. R. Barry. King, Gilbert M. Long John K. Sheldon, Lewis Publishers.
3. General Microbiology, 1995. Schlegel, H.G., Cambridge University Press.
4. Biotechnology, 1996. Smith, J.F., Cambridge University Press.
5. Environmental Biotechnology Principles and Applications, 2000.Pruce, R. Hmana, Parry McCarty, McGraw Hill.
6. Biodegradation and Remediation, 1999. Martin Alexander Academic Press Inc.

ZOL-6407 BIOCHEMISTRY-II Cr. Hrs. 2+1

Aims and Objectives

The course will provide in depth knowledge about the biochemical processes and organic compounds of life including macromolecules. The dynamism of the life proceeds with inter-conversion of the chemicals from feeding to the liberation of energy for work. It will deal with the inter-conversion performed by various tools called as enzymes. Thus, in this course the concepts of the chemical basis of life and all the mechanisms involved in harvesting of energy for growth, duplication etc., are given.

Course Contents

Constituents of living organisms, Prebiotic molecular evolution, Origin of biomolecules and living cells. Properties of aqueous solutions, Acid, Base, buffers and pH. Thermodynamics principles, Laws of thermodynamics, Free energy chemical equilibria. Characteristics and biological functions of amino acids, proteins, carbohydrates and lipids. DNA (double helix, DNA melting eukaryotic chromosomes), Synthesis of oligonucleotides RNA (messenger, transfer and ribosomal). Characteristics of enzymes activity. Metabolic pathways: Glycolysis; Citric acid cycle; Electron transport chain and Oxidative phosphorylation; Other pathways of carbohydrate metabolism. Photosynthesis. Lipid digestion, absorption and transport, Fatty acid oxidation and synthesis of ketone bodies and cholesterol metabolism. Biosynthesis of amino acids, amino acid deamination, decarboxylation, transamination, Urea Cycle. Nitrogen fixation. Nucleotide synthesis and degradation. Interrelation and regulation of metabolic pathways and energy metabolism.

Practicals

1. Qualitative tests of amino acids.
2. Qualitative estimation of proteins by UV and Lowry's method. Extraction and slating out of proteins. Gel filtration, Ion exchange chromatography and polyacrylamide gel electrophoresis of proteins. Determination of molecular size of proteins by SDS –PAGE.
3. Qualitative test of different lipids. Fractionation of brain lipids and their analysis by thin layer chromatography.
4. Qualitative test for carbohydrates. Glycogen isolation and hydrolysis. Determination of reducing sugars. Enzymatic determination of glucose. Paper chromatography of sugars.
5. Isolation of lactate dehydrogenase from heart muscles of rabbit and analysis of isoenzymes of PAGE. Isolation of peroxide from turnip and study of its kinetics.

Recommended Books

1. Voet, D and Voet, J.G. (1990). Biochemistry, John Wiley & Sons
2. Zubay, G.l. (1983). Biochemistry, McMillan Publishing Co.
3. Rawn, J.D (1989). Biochemistry, Neil Patterson Publishers, North Carolina.
4. Conn and Stumpf, (1989). Outlines of Biochemistry, John Wiley & Sons.
5. Stryer, L. (1988). Biochemistry, W. H. Freeman & Co., New York.
6. Davlin, J. (1992). Textbook of Biochemistry with Clinical Correlation, John Wiley & Sons.

ZOL-6408 MOLECULAR BIOLOGY Cr. Hrs. 2+1

Aims and objectives

Objectives of the course are to impart knowledge about the macromolecules in animal cell and their complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms.

Course Contents

Molecular Biology of DNA, RNA, Protein, Mechanism of DNA replication and DNA repair including involved enzymes. Prokaryotic and eukaryotic Transcription, post transcriptionmodifications in eukaryotes. Genetic code, Mechanism of Translation and eukaryotic post-translation modifications, Gene expression in prokaryotes and eukaryotes. Molecular biology of DNA and RNA viruses..

Practicals

Quantitative estimation of various macromolecules. Demonstration of properties of macromolecules. Methods of bacterial culture.

Recommended Books

1. Kornberg, A. (1980). DNA Replication, W.H. Freeman, San Francisco.
2. Kornberg, A. (1982). Supplement to DNA Replication, W.H. Freeman, San Francisco.
3. Old, R.W. and Primrose, S.B. (1981). Principles of Gene Manipulation, Blackwell, Oxford.
4. Watson, J.D., Hpkins, N.H., Roberts, J.W., Steitz, J.A. and Weiner, A.M. (1990). Molecular Biology of the Gene, Benjamin, California.
5. DuPraw, Advances in Cell and Molecular Biology, Academic Press.
6. Bukhari, A.I., Shapiro, J.A., and Adhya, S.L. (1977). DNA Insertion Elements, Plasmids and Episomes, Cold Spring Harbour Laboratories.
7. Stent, G.S., (1971). Molecular Genetics, Freeman, San Francisco.
8. Glass R.E., (1982). Gene Function: E. coli and its Heritable Elements, Croom Helm, London.
9. Adams, R.L.P., Knowler, J.T. and Leaer, D.P. (1986). The Biochemistry of the Nucleic Acids, Chapman and Hall.
10. Davis, R.W., Botstein, D. and Roth, J.R. (1980). Advanced Bacterial Genetics, Cold Spring Harbor Lab., N.Y.
11. Freifelder, D. (1983). Molecular Biology, A Comprehensive Introduction to Prokaryotes and Eukaryotes. Science Books International, Boston.

ZOL-6409 MEDICAL MICROBIOLOGY Cr. Hrs. 2+1

Aims and Objectives

Aims of this course are to let the students know about the science of microbiology, to work with microorganisms, their pathogenecity, and various diseases and problems caused by microorganisms. The course may also initiate their interest in agricultural, industrial and/or environmental microbiology. The course will enable the students to identify specific areas in practical life where the science of microbiology is being applied. Thus they can seek different job in various organizations such as clinical, industrial and environmental microbiology sections.

Course Contents

Microbiology and Medicine, antimicrobial agents, mode of action. Bacterial pathogenicity, sources and spread of the infections in the community. Immunological principles, antigen, antibodies and antigen-antibody reactions. Bacterial pathogens

and associated diseases. *Staphylococcu*s, skin and wound infections. *Streptococcus*, sore throat, scarlet fever, glomeruonephritis. *Pneumococcus*, respiratory infections. *Corynebacterium*. *Diphtheriae Mycobacterium tuberculosis*: Pulmonary and other tuberculosis infections. *Actinomyces. Neisseria meningitis*, *Gonorrhea*, *Salmonella, Shigella, Escherichia coli, Klebsiella proteus, Providenica, Bacillus anthracis. Clostridium tetani*. Pox viruses, Herpes viruses. Herpes simplex. Cytomegalovirus infections. Adenoviruses. Influenza viruses. Hepatitis viruses. Arbovirsus, Rickettsia, Pahtogenic. Fungi and Protozoa. Bird flu, Measles, Dengue.

Practicals

Basic techniques.(Staining of microorganisms: Simple stains, positive staining; negative staining. Demonstration of special structures by stains: Spore stain, Flagella stain. Differential stains: Gram stain, Metachromatic Granule stain, Acid fast stain. Culturing of microorganisms: Isolation of a bacterial culture. Quantitative plating methods) Widal test. Laboratory diagnosis and control of infections: Streptococcus. Corynebacterium, Listeria, Mycobacterium. The Entero bacteriaceae: Salmonella. *Escherichia, Klebsiella* and *Clostridium*. Blood tests: TLC, DLC, RBC.

Recommended Books

1. Kenneth Ryan, C. George Ray, Nafees Ahmad, W. Lawrence Drew, James Plorde. (2010). Sherris Medical Microbiology, Fifth Edition. McGraw Hill Publishers, Washington DC
2. Patrick R. Murry, Ken S. Rosenthal, Michael A. Pfaller: Medical Microbiology**,** 5th edition, Philadelphia: Elsevier/Mosby, 2005.
3. P.K. Murray, Ph.D., K.S. Rosenthal, Ph.D., G.S. Kobayashi, Ph.D., and M.A. Pfaller, MD, 4th Edition, Mosby, Inc. 2002. ISBN #0323012132
4. Sherris medical microbiology: an introduction to infectious diseases C. George Ray, Editor; McGraw-Hill/Appleton and Lange 5th edition, McGraw-Hill/Appleton & Lange, 2003. ISBN#0838585299
5. Microbial Applications (Complete Version) Laboratory Manual In General Microbiology, 1994. Benson, H.J. WMC Brown Publishers, England.
6. Microbiology, 1986. Pelczar Jr., Chan, E.C.S. and Krieg, M.R. McGraw Hill, London.
7. Brock Biology of Microorganisms, 1997. Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall, London.
8. Cruickshank, R, Duguid, J.P., Hermion, B.P. and Swain, R.H.A., (2003). Medical Microbiology. Churchill Livingstone, N.Y.
9. The Microbial World, 1986. Stainier, R.Y., Ingraham, J.L., Wheelis, M.L. and Painter, R.R. Prentice Hall, London.
10. Foundations in Microbiology. (1998). Talaro & Talaro. WCB Publishers, New York.
11. Microbiology: A Human Perspective, 2001. Eugene W. Nester, Denise, G., Anderson, Martha, T., Nester, C., Evans Roberts, Nancy, N. McGraw Hill Higher

Education.

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

ZOL-6410 APPLIED MICROBIOLOGY Cr. Hrs. 2+1

Aims and Objectives

Aims of this course is to let the students know about the applications of the science of microbiology in the different fields of life. The course may initiate their interest in agricultural, industrial and/or environmental microbiology.

Course Contents

Control of microorganisms: Fundamentals of control, control by physical and chemical agents, antibiotics and other chemotherapeutic agents. Microorganisms and diseases: Host-microbe interactions. Resistance and immunity. Air, food and water-borne human infections. Human contact diseases. Infectious diseases of animals. Environmental microbiology: Fundamentals of microbial ecology. Microbiology of air. Aquatic microbiology. Soil microbiology. Microbiology of domestic water and sewage. Microbiology of food, milk and milk products. Industrial Microbiology: Scope of industrial microbiology in food production, control of insects, human therapy, petroleum, mining and bioremediation. Biotechnology and its role in modern human comforts.

Practicals

1. Bacteriological examination of water. Isolation and Identification of enteric pathogen. Selective medium for the isolation of pathogenic Staphylococci. The coagulase test for pathogenic *Staphylococcus*, Sucrose plates. *Streptococcus silvarius*. Normal throat flora and reactions on Blood Agar. Slide Agglutination test.
2. Inhibition and destruction of microorganisms by physical agents (temperature, desiccation, light). Action of disinfectants on bacteria. Bacteriostatic action of certain dyes and drugs.

Recommended Books

1. Eugene W. N., Denise, G., Anderson, M. T., Nester, C., Roberts, E. Nancy, N. Microbiology: A Human Perspective, 2001. McGraw Hill Higher Education.
2. Jacquelyn, G.G. Microbiology Principles and Explorations, 2001. John Wiley & Sone Inc.
3. Pelczar Jr., Chan, E.C.S. and Krieg, M.R., Microbiology, 1986. McGraw Hill, London.
4. Benson, H.J. Microbial Applications: LAB Manual In General Microbiology, 1998. WMC Brown Publishers, UK.

ZOL-6411 MEDICAL PARASITOLOGY Cr. Hrs. 2+1

Course Contents

Systematic, biology, pathology, host parasite relationships. Study of parasites belonging to phyla: Protozoa Platyhelminthes, Nematoda, Annelida and Arthropoda. Study of parasitic diseases in animals and humans and their control.

PRACTICAL:
Methods of collection, preservation and transportation of parasitic material. Isolation of these parasites from different sources and their identification. Identification of insects of medical and veterinary importance.

Recommended Books

1. Noble and Noble, 1982. Parasitology. The Biology of Animal Parasites. 5th edition. Lea and Febiger.
2. Beck, J.W. and Davies, J.E., 1981. Medical Parasitology. 3rd edition. The C.V. Mosby Company, Toronto, London.
3. Cheesbrough, M., 1987. Medical Laboratory Manual for Tropical Medicine. Vol. I. University Press Cambridge.
4. Smith, J.D., 1994. Introduction to Animal Parsitology. Cambridge University Press.
5. Roberts, L.S. and Janovy, J.Jr., 2001. Foundations of Parasitology. 5th Edition. Wm Brown Publishers, Chicago, London, Tokyo, Toronto.
6. Urquhart, G.M., Hucan, J.L., Dunn, A.M. and Jennings, F.W., 2000. Veterinary Parasitlogy Longman Scientific and Technical publications, Longman Group, U.K.

ZOL-6412 HELMINTHOLOGY Cr. Hrs. 2+1

Aims and Objectives

This course aims at introducing the common parasites of man and livestock to students with a view to understand their lifecycles, morphology, pathology, diagnosis, epidemiology and control.

Course Contents

Introduction to the phylum: Platyhelminthes, Trematoda, Aspidohothria, Trematoda, Form function, Life cycle and classification of digeneans, Digenians, Strigeiformes, *Schistosoma haematobium, S. japonicum, S. mansoni* (schistosomiasis); Digenians echinostomiformes; *Fasciola hepatica, F gigantica, Paramphistomum cervi.* Nematodes, Taenia, Cestodes.

Recommended Books

1. Chandler, C. and Read, C.P. 1961. Wiley Toppan. Introduction to Parasitology.
2. Crewe, W.H.K. 1977. A Guide to Human Parasitology, Lowis and Company Ltd.
3. Noble and Noble, 1982. Parasitology. The Biology of Animal Parasites, Lea and Febiger.
4. Beck, J. W. and Davies, J.E. 1981. Medical Parasitology Mosby Company, Toronto, London.
5. Cheesbrough, M. Medical 1987. Laboratory Manual For Tropical Medicine, Vol. I. University Press Cambridge.
6. Sood, R. 1998. Parasitology: Protozoology And Helminthology,

7. Smith, J.D. 1998. Introduction to Animal Parasitology, University Cambridge Press.
8. Roberts, L.S. and Janovy, J. Jr. 2000. Foundations of Parasitology, Brown Publishers, Chicago, London.

ZOL-6413 VECTOR BIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course aims to provide students with a broad understanding of the key aspects of insect vector behaviour, vector ecology and vector-parasite interactions relevant to the epidemiology and control of vector-borne diseases.

Course Contents

Detailed studies of systematic, Biology and ecology of some vectors of medical importance (order Diptera) Mosquitoes: Anopheles mosquitoes, culicine mosquitoes, Black flies, Sand flies, biting midges, horse flies, deer flies and clegs, tsetse flies, house flies, myiasia producing flies, (blow flies, blue bottles, green bottles, flesh flies, warble flies and bot flies). The study will cover following aspects: Morphology, anatomy, distribution, breeding habits, life-cycle, pathogenesis and seasonal prevalence of the species. Brief account of diseases spread by these vectors, methods of control, modern trends in their biological and chemical control.

Practicals

Methods of identification; Dissection of selected vectors i.e. mosquito, house flies, blue bottles, green bottles and bot flies. Study of prepared slides of parasites. Epidemiological studies of Vector born diseases (one e.g. malaria) including field studies of control methods and parasite evaluation.

Recommended Books

1. William A. Riley. Medical Entomology. McGraw Hill Book Co. Inc. London.
2. McDonald, G. The Epidemiology and Control of Malaria, London Oxford Press.
3. World Health Organization. Vector Control Series, Training and information guide. The House fly.
4. World Health Importance Geneva, WHO, 1988.
5. Walker, A. 1998. Arthropods of human and domestic animals. A guide to preliminary identification. Chapman & Hall.
6. Service, M.W. 1980. A guide to medical entomology. The McMillan Company, New York.
7. Herms, W.B. and James, M.T. 1960. Medical entomology. The McMillan Company, New York.

ZOL-6414 ANIMAL PESTS AND DISEASE PRODUCING ORGANISMS Cr. Hrs. 2+1

Aims and Objectives

The course aims to provide knowledge and awareness to students about the different invertebrates and invertebrates animal pests and to equip the student with suficient knowlege to generate technologies and strategies being used for pest and disease management include testing new pesticides (chemical and biological) for inclusion in integrated pest management (IPM), to counter this challenge.

Course Contents

Nature and mechanism of damages caused by animals pest injuries to cash crops, vegetables and fruit plants, stored grains and forest plants with brief description of their biology, ecology and control. Role of insects, helminthes, nematodes, protozoans and other pathogens in disease transmission and myiasis. Insects and mites of medical and veterinary importance in Pakistan. Study of mammalian pests of Pakistan.

Practicals: Collection, mounting studying and identification of important animal pests. Endo and ecto-parasite of various animals. Mounting of slides after processing the parasites.

Recommended Books

1. Ahmad, M., 1990. Agricultural Entomology of Pakistan. Nalt. Long Auth, Islamabad.
2. Choudhry, G.U. 1970. Survey of insect fauna of forests of Pakistan.
3. Ghani, M.A. and Cheema, M.A. 1973. Biology, ecology and behaviour of principal natural enemies of major insects pests of forests of Pakistan.
4. USDA, 1956. Year Book of Agriculture, Insects.

ZOL-6415 FISH PHYSIOLOGY Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to provide sufficient knowledge about all physiological phenomena in fishes. The subject provides practicals information to obtain better growth by following physiological aspects during extensive or semi-intensive culture.

Course Contents

Food digestion and nutrition. blood circulation, respiration, excretion, reproduction, learning and memory. Ethyological analysis of fish behaviour. Biological rhythm and fish migration.

Practicals

Study of the different species of fish to acquire knowledge of the major feeding types with special emphasis on feeding adaptations and modification in the shape of the mouth. Study of adaptations for air breathing. Study of adaptation for air breathing among fishes and study of accuracy respiratory structure in fishes. Determination of O_2 and NH_3 in water.

Recommended Books

1. Lagler, K.F., (1977). Ichthyology.

2. Norman, J. R. And Greenwood, P.H. (1975). A History Of Fishes.
3. Kestin, S. C. And Warris, P. D. (Edition). Kestin Farmed Fish Quality, 2002. Blackwell Science, Oxford, UK.
4. Saksena, D. N. Ichthyology: Recent Research Advances. 1999. Oscar Publications. India.

ZOL-6416 ICHTHYOLOGY (FISH MORPHOLOGY) Cr. Hrs. 2+1

Aims and Objectives

The purpose of this course is to provide students with a thorough introduction to fundamental ichthyology with emphasis on aspects of fish anatomy, biology and form and function.

Course Contents

Basic Morphology, Systematic, Zoogeography of fin fishes, shell fishes and crustaceans with special references to Pakistan. Brief survey of world fisheries and non-fish resources. Fishing Technology, fish preservation, Shelf life of fisheries of various types.

Practicals

Collection and identification of local fishes (fin fishes and shell fishes) and study of anatomy of selected fishes.

Recommended Books

1. Lagler, K.F. (1977). Ichthyology.
2. Norman, J.R. and Green wood, P.H. (1975). A history of fishes.
3. Kestin, S. C. and Warris, P. D. (Edition). Kestin Farmed Fish Quality, 2002. Blackwell Science, Oxford, UK.
4. Huet M. Text Book of Fish Culture: Breeding and Cultivation. 1973. Blackwell Publishing Company.

ZOL-6417 LIMNOLOGY-B Cr. Hrs. 2+1

Aims and Objectives

Limnology is the study of inland waters – lakes (both freshwater and saline), reservoirs, rivers, streams, wetlands, and groundwater – as ecological systems interacting with their drainage basins and the atmosphere. The limnological discipline integrates the functional relationships of growth, adaptation, nutrient cycles, and biological productivity with species composition, and describes and evaluates how physical, chemical, and biological environments regulate these relationships.

Course Contents

Dynamics of lotic and lentic series, Organisms in lotic and lentic environments, Influence of physical and chemical conditions on biota and their

adaptations to physical and chemical conditions, Bacteria and other fungi, Nektons, Biological productivity.

Practicals

Collection, preservation and study of fauna and flora of various approachable water bodies; preparation of slides of microfauna and flora, identification, study of adaptive characteristics of animals and plants.

Recommended Books

1. Agrawal, S.C. 1999. Limnology. A.P.H. Publishing Corporation, N. Dehli.
2. Goldman, C.R. and Home, A.J. 1983. Limnology, McGraw Hill, International Book.
3. Welch, P.S. 1968. Limnology 8th Edition, McGraw Hill Book Co.l Inc., New York.
4. Singh, H.R. Advances in Limnology. Narendra. Publishing House, N. Delhi.
5. Allen S.E. 1990. Chemical Analysis of Ecological Materials. Scientific Publishers, London.

ZOL-6418 VERTEBRATA Cr. Hrs. 2+1

Aims and Objectives

The course provides knowledge and understanding about the classification, characteristics and physiological adoptation of different vertebrate animal groups, emphasizing their phylogenetic relationships.

Course Contents

Protochordates; Characteristics of vertebrates; Classification of vertebrates up to orders with examples, excluding Fossils except Archaeopteryx. Comparative vertebrates morphogenesis: Egg type, Cleavage, Blastula, Gastrulation, detailed account with support from Spemann's experiments. Comparative Anatomy and function of integumentary skeletal (General details such as structure of bones, cartilage, limb, evolution of limbs, digestive, circulatory, respiratory, excretory and nervous (including sense organs) system.

Practicals

1. Museum study: Identification of common vertebrates and lower chordates.
2. Examination of the following prepared Slides
3. Whole mount of Amphioxus sp. T.S. Amphioxus through different regions. Pharynx of ascidians. Sections of skin of fish, frog and rabbit. Section of mammalian liver, kidney, spleen, thyroid gland, testes, ovary, heart muscle, pancreas, nerve card, lungs and Intestine etc. Whole mounts and histological sections of different developmental stages of chick.

Recommended Books

1. Kent, G.C. Comparative Anatomy of the Vertebrates .Mosby Company.
2. Hashmi, T. H. and Bhatti, H.K. Chordate Zoology. Carvan book house Lahore.
3. Romer, A.S. (1962). The Vertebrate Body. W. B. Saunders Company, Philadelipha.

ZOL-6419 ORNITHOLOGY Cr. Hrs. 2+1

Aims and Objectives

The course provides knowledge about general characteristics, classification, behaviour, evolution and geographical distribution of birds and will help to understand the basic physiological adaptations of birds with reference to different environmental conditions.

Course Contents

Introduction, evolution, geographical distribution and classification. Characteristics of birds, external features, identification of sex and age, reproduction and development, behaviour (migration, territoriality), populations and their regulation. Anatomical, physiological adaptations to their environment, reproductive strategies, food/feed, communication (vocal, behavioural). Anatomy & physiology of game and predatory species. Birds of Pakistan: Aquatic, Forest, Game birds and birds of prey. Birds as pests.

Practicals

1. Visit of PMNH for study of preserved specimens of different groups of birds in relation to their taxonomy and ecosystem etc.
2. Field visits for bird watching (population estimation, nesting, vocal calls, feeding & other behaviours etc.) in different ecologies in the vicinity of Muzaffarabad areas.
3. Visit to zoos and wildlife parks.

Recommended Books

1. Kaiser, G. W. (2008). The Inner Bird: Anatomy and Evolution. Amazon Co.
2. Howell, S. N. G. (2010). Peterson Reference Guide to Molt in North American Birds (Peterson Reference Guides. Amazon Co.
3. Richard Grimmett, Carol Inskipp and Tim Inskipp (2008). Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives. Princeton Book Co.
4. A J Urfi (2009). Birds of India: A Literary Companion, OUP.
5. Frank B. Gill. (2004). Ornithology. 2nd Ed. W. H. Freeman & Co.
6. Handbook of Bird Biology by Cornell Lab of Ornithology. Princeton University Press. New Jersey. 2004.

7. Salim Ali and S. Dillon Ripley (2001). Handbook of the Birds of India and Pakistan: Together with Those of Bangladesh, Nepal, Bhutan and Sri Lanka/. Reprint. New Delhi, Oxford University Press, 10 Vols.
8. Noble S. Proctor, Patrick Lynch, Patrick J. Lynch, Patrick J. Lynch (1998). Manual of Ornithology: Avian Structure and Function. Yale University Press.
9. Audubon Handbook: How to Identify Birds? 88th ed. Mcgraw-Hill Publishing Company.
10. Roberts, T.J. 1992. Birds of Pakistan. Vol 1& 2. Oxford University Press.

ZOL-6420 MAMMALOGY Cr. Hrs. 2+1

Aims and Objectives

The purpose of this course is to acquaint students with the origin, evolution, identification, characteristics, systematics, life history, and adaptive strategies of the Mammalia and to expose them to field techniques used in their study.

Course Contents

Classification of mammals (including Mesozoic mammals: Triconodonts, Symmetrodonts, Multituberculates, Docodonts and pantotheres); Mammalian characteristics; The Monotremes, Marsupials and Placental mammals; Specialization of Mammalian teeth; Mammalian molar and its origin (Tritubercular Theory); Distribution, Dispersal; Territory and Territoriality; Classification of mammals according to their diet; Food and food storage in mammals; Hibernation and Aestivation; Defense and Protection; Movement in mammals (running, leaping, fossorial, swimming, arboreal, flying and gliding mammals); Origin and evolution of mammals.

Practicals

1. General survey and classification up to species of important mammals
2. Skeleton of Mongoose or Cat, Hedgehog and Rabbit.

Recommended Books

1. Terry, A. Vaughan, J.M. Ryan and N.J. Czaplewski, 2009. Mammalogy 5th Ed. Jones and Bartlett Publishers.
2. F. Harvey, Pough, Christine, M. Janis, John, B. Heiser. Vertebrate Life. 2003. Pearson Education.
3. Hickman, Roberts, and Larsen, 2005, Integrated principles of Zoology (13th Edition). McGraw Hill, New York.
4. David, D., 1963. Principles of Mammalogy.
5. Davis. Principles of Mammalogy.
6. Gelder, Biology of Mammals.
7. Miller and Harley, 1999. Zoology (8th Edition).
8. Hickman, Roberts, and Larsen, 2001. Integrated Principles of Zoology (11th Edition).

ZOL-6421 WILDLIFE Cr. Hrs. 2+1

Aims and Objectives

The aim of this course is to familiarize students with wildlife, its values, ecology and management with special reference to Pakistan and AJK by: (1) exploring the ecological processes affecting wildlife, and (2) discussing various national and international measures and challenges in conserving wildlife.

Course Contents

Introduction to wildlife, Wildlife of Pakistan, Identification, classification, distribution, and conservation status of mammals, birds, reptiles & amphibians of Pakistan & AJK. Introduction to major wildlife habitats in Pakistan/AJK. Philosophy and significance of wildlife conservation. Conservation of wildlife: *in-situ* and *ex-situ* conservation approaches. Wildlife management in Pakistan/AJK. Wildlife laws/regulations in Pakistan/AJK. National and International agencies involved in conservation and management of wildlife. Introduction to some modern techniques (Radio telemetry, remote camera, TIR, GPS, GIS, RS, molecular analysis) used in wildlife conservation. Protected areas (Sanctuaries, Game Reserves and National Parks) in Pakistan/AJK. Human-wildlife conflict and its mitigation.

Practicals

6. Study of museum specimens and their classification (Birds and Mammals)
7. Demonstration of distribution of avian and mammalian fauna of Pakistan. (Blank maps may be provided).
8. Study of Birds and mammals censing techniques.
9. Use of GPS in field studies.
10. Visit of Zoos and protected areas

Recommended Books

21. Roberts, T.J. (1997). Mammals of Pakistan. Oxford University Press, Karachi.
22. Bailey, J.A., 1986. Principles of Wildlife Management, John Wiley.
23. Gaston, G. and J. Spicer. 2007. Biodiversity. Blackwell Publishing & Co. London, UK.
24. Grimmett, R. Inskipp, C. and Inskipp, T., 2001, Birds of the Indian Sub-Continent. Helm.
25. Grimmett, R. Roberts, T. J and Inskipp, T. 2008. Birds of Pakistan. Helm Field Guide.
26. Hickman, Roberts, and Larsen, 2003. Animal Diversity (3rd Edition).McGraw Hill, New York.
27. Hickman, Roberts, and Larsen, 2008. Integrated principles of Zoology (12th Edition).McGraw Hill, New York.
28. Jordan, E. L. and Verma, P. S. 2011.Invertebrate Zoology, S. Chand and Company.
29. M.S. Khan. 2006. Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Florida USA.
30. M. M. Shafique, 2005. Wildlife Acts and Rules of Pakistan. PFI, Peshawar.
31. Miller and Harly, 2007. Zoology (7th Edition). McGraw Hill, New York.

32. Mirza, Z. B. 1998. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
33. Mitsch, W. J. and Gosselink, J. G. 2007. Wetlands 8th ed. John Wiley & Sons, Inc.
34. Azad Jammu and Kashmir, Wildlife (Protection, Preservation, Conservation and Management) Ordinance, 2009
35. Roberts, T. J. 1991. Birds of Pakistan. Vol. I Oxford University Press
36. Roberts, T. J. 1992. Birds of Pakistan. Vol. II. Oxford University Press
37. Roberts, T. J. 2005. Field Guide to the large and Medium-sized Mammals of Pakistan. Oxford University Press
38. Roberts, T. J. 2005. Field Guide to the small Mammals of Pakistan. Oxford University Press.
39. Robinson, W.L. and Bolen, E.G., 1988. Wildlife Ecology and Management. McMillan, Cambridge.
40. Akbar, G and M. Anwar (Eds.). 2011. Wildlife of Western Himalayan Region of Pakistan (Northern Mountains). WWF-Pakistan. 378pp.

ZOL-6422 ENVIRONMENTAL ISSUES Cr. Hrs. 2+1

Aims and Objectives

This course is designed to provide students with an appreciation for the complexity of environmental issues and an awareness of the tools that can be applied to understand and solve problems involving the environment.

Course Contents

Life a factor of rapid change in the environment, Population increase of diversified life in an ecosystem, Population system in an ecosystem balance; Mechanisms inter-playing in balance, consequences of imbalance, Endangering and extinction of species, decline of biodiversity, consequences of losing biodiversity. Human population: Main actor in an environment, Human population explosion, Technologies in sustaining population and affluence, addressing population problem, population and development. Poverty; integrated approach to alleviate poverty, Life style: Urban sprawl, consequences of ex-urban migration, Health in life style; Environment and health. Food production (Crops and livestock). Land for cultivation and farming. Food production, its distribution, economics and politics, Hunger, malnutrition and famine, Soil, irrigation, Stalinization, Desertification, Losing soil/ground. Pests and pest controls: Need and approach to pest control. Alternate pest control methods. Socio-economic pressure and pest management, Environmental policy in pest management. Water: Water cycle and water management, Human impact on water resources. Pollution. Bi-products of production systems: Sediments, Nutrients and eutrophication, the process and symptoms of eutrophication, combating eutrophication, long term strategies. Sewage pollution: Sewage hazards and potential, sewage management, recycling and impediment to recycling. Hazardous chemical pollution: Nature and chemical risks, pollution sources and control. Major atmospheric changes: Acid deposition, Global warming/cooling, Green house effect, Ozone depletion. Solid wastes (trash): Landfills, combustion, solutions and management. Energy resources (Fuel of production and development):

energy sources and uses, fossil fuel, alternate fossil fuel; Nuclear Power, promises and problems, sustainable energy option, solar and other renewable energy sources. Environmental issues of Pakistan: Ecological issues (Soil erosion, deforestation, issues related to irrigated system, natural hazards), issues related to conservation of habitat and biodiversity (major threats to biodiversity in Pakistan, conservation strategy), pollution and industrial resources (water issues, air issues, soil issues, mineral resources issues, energy issues, food, population issues and socio-economic issues.

Practicals

Review, reports, field trips, discussions on current local, national, regional and global issues. Approaches and strategies, mitigation measures.

Recommended Books

1. Botkin, D.B. and Keller, E.A. 2008. Environmental science (Earth as a living planet). 3rd Ed. John Wiley and Sons Inc. N.Y, USA.
2. Ahmad, R.Z. 2000. Pakistan-A-descriptive Atlas (A comprehensive geopolitics Course). 1st Ed. Ferozsons Pvt. Ltd. Lahore Pakistan.
3. Nebel, B.J. and Wright, R.t. 1998. Environmental Sciences (the way the world works). 1st Ed. Prentice Hall International Inc. London, UK.
4. Gaston, K.J. and Spicer, J.I. 1998. 'Biodiversity (An Introduction), 1st Ed. Blackwell Science Ltd. UK.
5. Brandbury, I.K. 1998. The Biosphere. 2nd Ed. John Wiley and Sons Inc. UK.
6. Mckinny, M.L. and Schoch, R.M 1998. Environmental Science (systems and solutions). Jones and Artlett Publications Inc. USA.
7. Emiliani, C. 1997. Planet Earth (Cosmology, geology and the evolution of life and environment). 3rd Ed. Cambridge. University Press, UK.
8. Khan, F.K. Geography of Pakistan Environment (Environment, People and economy). 1993. Oxford University Press, NY, USA.
9. Hussain, S.S. 1992. Pakistan manual of plant ecology (A text book of plant ecology for degree students). National Book Foundation, Islamabad, Pakistan.
10. Daily news papers for current issues.

ANNEXURE-V

CURRICULUM FOR M. PHIL ZOOLOGY

DEPARTMENT OF ZOOLOGY

MIRPUR UNIVERSITY OF SCIENCE & TECHNOLOGY

MIRPUR (AJ&K)

M. PHIL DEGREE PROGRAM

Introduction

M Phil degree is a research based specialization that provides a systematic research, critical analysis, problem recognition and solution designing abilities to a scholar. One year academic activities are followed by one year research activity. At the end of research, thesis is written by scholar is evaluated by internal and external examiner. A public defense is notified by the department and scholar defend thesis publically. Scholar needs strong communication skills, usually developed through assignment and seminar presentations held in earlier semesters. Degree is awarded at the end of successful public defense. M. Phil in zoology gives wide chances of job in public and private sector DAIs, colleges, research organizations, industries, abroad institutions and would pave a way for doctoral studies.

Program Mission Statement

M. Phil zoology program aims to impart solution based philosophical and research aptitude to the emerging problems in zoology.

Program Objectives

1. To enhance the professional capabilities of scholars and empowers them with the most advanced and contemporary comprehension of zoology.
2. To provide healthier opportunities and latest research methodologies for cutting edge basic and applied research relevant to national and global needs and develop scholars innovative, novel and critical perspectives on research problem.
3. To develop strong communication and managerial skills, multidisciplinary and collaborative scientific culture among scholars.
4. To inculcate ethical values in scholars for the betterment of the humanity.
5. To provide students with opportunities to publish their research work in reputed national and international journals.

Program Outcomes

At the completion of M. Phil in Zoology;

1. The scholars have an extensive base in the up to date and applied research fields of the subject and can hunt their specialized area of research.
2. The scholars encompass a deep understanding of zoological phenomenon, critiquing, planning, analysis of quantitative and qualitative research in the area of interest, and illustrating a meaningful solution of a research problem.
3. Scholar would be able to prosper their team work abilities, leadership role, performance, and establish relationships with other universities and industry.
4. Scholars contain a profound comprehension of professional and ethical standards and must continue these values as a benchmark of the quality of education in zoology.
5. Publication would be made in reputed HEC recognized national and international journals.

SCHEME OF STUDY FOR M. Phil

Scheme of Study for M Phil

Duration	4-6 Semesters
Courses	24 Credits
Seminars	01 Credit
Thesis	06 Credits
Total Credits	31 Credits

List of Elective Courses for M. Phil Zoology

CODE	COURSE	CREDIT HRS
ZOL-701	Human Embryology and Teratology	3
ZOL-702	General and Comparative Endocrinology	3
ZOL-703	Advances in Molecular Cell Biology	3
ZOL-704	Advances in Molecular Genetics	3
ZOL-705	Advances in Human Genetics	3
ZOL-706	Bioethics	3
ZOL-707	Bioinformatics	3
ZOL-708	Cancer Genetics	3

ZOL-709	Systemic Toxicology	3
ZOL-710	Fundamentals of Microbiology	3
ZOL-711	Biology and Control of Vertebrate Pests	3
ZOL-712	Fish Physiology and Breeding	3
ZOL-713	Advances in Aquaculture	3
ZOL-714	Conservation Biology of Wildlife	3
ZOL-715	Wildlife Diversity of Pakistan and AJ&K	3
ZOL-716	Advances in Environmental Biology	3
ZOL-717	Fundamentals of Biotechnology	3
ZOL-718	Instrumental Techniques	3
ZOL-719	Advances in Developmental Biology	3
ZOL-720	Advances in Medical Parasitology	3
ZOL-721	Advances in Reproductive Physiology	3
ZOL-722	Recombinant DNA Technology	3
ZOL-723	Advances in Microbiology	3
ZOL-724	Wildlife Conservation of Pakistan and Azad Jammu & Kashmir	3
ZOL-725	Diagnostic Techniques in Molecular Genetics	3
ZOL-726	Applied and Experimental Statistics	3
ZOL-727	Comparative Physiology	3
ZOL-728	Comparative Vertebrate Endocrinology	3
ZOL-729	Physiology of Co-ordination	3
ZOL-730	Molecular Physiology of Gene Expression and Function	3
ZOL-731	Environmental Biotechnology	3
ZOL-732	Application of Biotechnology	3
ZOL-733	Population Genetics	3
ZOL-734	Biochemistry of Drug Action	3
ZOL-735	Applied Entomology	3
ZOL-736	Behavioural Ecology	3
ZOL-737	Biology of Birds and Mammals in Pakistan and AJK	3

ZOL-738	Principles of Wildlife Management	3
ZOL-739	Advances in Immunology	3
ZOL-740	Industrial and Pharmaceutical Microbiology	3
ZOL-741	Medical Biotechnology	3
ZOL-742	Microbial Genomics	3
ZOL-743	Principle and Kinetics of Toxicology	3
ZOL-744	Regulation of Gene Expression	3
ZOL-745	Protected Areas Management, Ecological Restoration and Sustainable Development	3
ZOL-746	Biological Toxicology	3
ZOL-747	Enzyme Technology	3
ZOL-748	Environmental Health	3
ZOL-749	Research Methodology and Scientific Writing	3
ZOL-750	Fish Bioenergetics	3
ZOL-751	GIS Techniques	3
ZOL-752	Restoration Ecology and Sustainable Development	3
ZOL-753	Advances in Plasma Biology	3
ZOL-754	Plasma Medicine	3
ZOL-755	Biological Tools, Techniques and Research Design	3

CONTENTS OF ELECTIVE COURSES FOR M. Phil ZOOLOGY

ZOL-701 HUMAN EMBRYOLOGY AND TERATOLOGY Cr. Hrs. 3

Course Contents

Formation of normal and abnormal gametes and their relation to age, gastrulation and implantation. Formation of basic organ rudiments. Development of

fetal membranes and formation of the placenta. Embryonic and fetal growth. Brief description of development of various body systems. Congenital malformations and their causes.

Recommended Books (Latest Edition)

1. Moore, K.L., The Developing Human, Saunders.
2. Largman, J., Medical Embryology, William and Wilkins.
3. Snell, R.S., Clinical Embryology, Little Brown.
4. Carlson. B. Human Embryology and Developmental Biolgoy. Saunders

ZOL-702 GENERAL AND COMPARATIVE ENDOCRINOLOGY Cr. Hrs. 3

Course Contents

The endocrine system; Type of hormones; Endocrine and nervous system relationship; General principles in function, interaction, nature, synthesis, transport of hormones; General concept of feed back, biorhythms, Evolution of endocrine system. Hypothalamus and pituitary: Hypothalamic hormones: Origin, chemistry and actions; Anterior pituitary & hormones: Hypothalamic pituitary regulation, General chemistry, Physiological action and metabolism of prolactin-growth hormone family, glycoprotein hormone family, corticotrophins and other pro-opiomelanocortin peptides; posterior pituitary: release, regulation and actions of vasopressin and oxytocin.

Thyroid gland: Anatomy and histology of gland; formation and secretion of thyroid hormones; thyroid hormones in peripheral tissues, Regulation and factors affecting thyroid function. Calciotrophic and mineral metabolism. Hormones: Chemistry, physiological actions and metabolism of parathyroid hormone, calcitonin and calciferols; Homeostasis of calcium, Phosphate and magnesium.

Pancreatic Hormones and regulatory peptides of the gut: Anatomy and histology for sources of the hormones; Chemistry, physiological roles and mechanism of action of insulin and glucagon; Physiological roles of gut peptides. Adrenal medulla and catecholamines: Chromaffin cell and organization; structure of adrenal medulla; Biosynthesis, storage, release and metabolism; Adrenergic receptors. Adrenal Cortex: Steroid biochemistry; Physiological actions of corticoid hormones; Regulation and metabolism of glucocorticoides, mineralocorticoides and adrenal sex steroids. Testes: Androgenic tissue: structure and chemistry; transport metabolism and mechanism of action. Ovaries: Ovarian hormones: Steroid biochemistry and biosynthesis; transport, metabolism and mechanism of action. Endocrinology of Pregnancy: Hormones in conception and implantation; Hormonal actions and adaptation in pregnancy and parturition. Hormones in lactation. Endocrinology of Heart, Kidney, Immune system: Growth and pineal gland. Overview of endocrine mechanisms in invertebrates.

Recommended Books (Latest Edition)

1. Greenspan, F.S. and Strewler, G.J., Basic and clinical endocrinology, 5th edition. Prentice Hall International Inc., London.
2. DeGroot, L.J., Jameson, J.L. Endocrinology, Vol.I, II & III, 4th Edition. W.B. Saunders, Philadelphia.
3. Giffin, J.E. and Ojeda, S.R., Textbook of Endocrine Physiology. Oxford University Press, Oxford.
4. Neal, J.M., Basic Endocrinology: An interactive approach. Blackwell Science Inc., London.
5. Wilson, J.D., Foster, D.W., Kronenberg, H.M. and Larsen, P. R. Williams Textbook of Endocrinology, W.D. Saunders Company, Philadelphia.

ZOL-703 ADVANCES IN MOLECULAR CELL BIOLOGY Cr. Hrs. 3

Course Contents

DNA replication overview, DNA replication: Control Mechanisms in Prokaryotes, DNA replication: Control Mechanisms in Eukaryotes, Cell cycle, checkpoints and control mechanisms, DNA repair mechanisms, Transcription overview, Post Transcription modification, Regulation of Transcription: Prokaryotes, Transcription Regulation in Eukaryotes, Control Levels, Control of gene expression: Basic mechanism, Remote Control of Gene Expression, Methods used to study Gene expression, DNA methylation and genetic imprinting, Gene Silencing.

Recommended Books (Latest Edition)

1. Alberts, Bruce; Johnson, Alexander; Lewis, Julian; Raff, Martin; Robert, Keith; Walter, New York and London: Garland Science; 2002, Molecular Biology of the Cell.
2. Cooper, Geoffrey M. The Cell – A Molecular Approach Sunderland (MA): Sinauer Associates, Inc.;
3. Lodish, Harvey; Berk, Arnold; Zipursky, S. Lawrence; Matsudaira, Paul; Baltimore, David; Darnell, James E. New York: W.H. Freeman & Co.; Molecular Cell Biology.
4. Karp, J. Cell and Molecular Biology, Concepts and Experiments, Jhon Wiley and Sons, INC.

ZOL-704 ADVANCES IN MOLECULAR GENETICS Cr. Hrs. 3

Course Contents

Genome structure, Prokaryote and Eukaryote gene, molecular definition of agene, Solitary genes and gene families, three major fractions of genome, Simple sequence repeats and finger printing, Eukaryotic Gene Clusters and their Transcription, Transposable genetic elements, DNA methylation and Cancer, Repeat

instability, repeat instability and genetic diseases, Imprinting, Differential methylation and cancer, Epigenetics and its implications in the genome, Replication and Transcription shaping the genome, Telomere and Telomerase and their role in cancer and aging, applications, RNA interference, RNAi mediated pathways in nucleus, therapeutic potential for human diseases.

Recommended Books (Latest Edition)

1. Baily Jill. Evolution and Genetics: The Molecules of Inheritance, Oxford University Press, New York.
2. Bittar E Edrard, Bittar Neville. Molecular and Cellular Genetics, Principles of Medical Biology series, volume 5, JAI Press, Greenwich.
3. Goldstein DB, SchlöttererMicrosatellites. Evolution and Applications, (Oxford University Press.
4. Singh Keshav K. Mitochondrial DNA Mutations in Aging, Disease, and Cancer, Springer, New York,
5. Woodruff Ronny C, Thompson James N. Mutation and Evolution, Contemporary Issues in Genetics and Evolution, volume 7, Kluwer Academic Publishers, Boston.
6. Woodward Dow O, Woodward Val W. Concepts of Molecular Genetics: Information Flow in Genetics and Evolution, McGraw-Hill series in population biology, McGraw-Hill, New York.
7. Anil Kumar, AK Srivastava. Advanced Topics in Molecular Biology, Publisher: Horizon Scientific Press.

ZOL-705 ADVANCES IN HUMAN GENETICS Cr. Hrs. 3

Course Contents

Simple Autosomal inheritance. Lethal genes. Chromosomal abnormalities. Multiple alleles and blood group. Linkage and crossing over. Variation in the expression of the genes. The study of twins as a special method of genetic inference. Mutation and DNA repair, organization of Human Genome.

Pedigree analysis. Ability to test PTC. Human chromosomes (slides). Study of inheritance of some humane characteristic-hair color eye color hair former loves, tongue rolling., DNA- Extraction.

Recommended Books (Latest Edition)

1. Stern C., The principle of human genetics, Freeman, sanfransisco.
2. Levitan, and Montagu, Text book of human genetics, Oxford University Press.
3. Harris. Human, Biochemical genetics, Cambridge University Press.

4. Sutton EH Genes enzymes and inherited diseases, Holt Rinehart and Winston.

ZOL-706 BIOETHICS Cr. Hrs. 3

Course Contents

Modern Biotechnology and its social implications. Biomedical research and bioethics. Safety and benefits of genetic testing. Experimentation on human embryos, stem cell research. GMOs, Genetically modified food and biosafety. Indigenous knowledge and patenting, commercialization and benefit sharing. National bioethic committees. Regulation of biotechnology for benefit sharing.

Recommended Books (Latest Edition)

1. M. Chalmer Cross-Cultural Biotechnology Rowma & Littlefield Publishers.
2. G. Poppy, M. Wilkinson. Gene Flow form genetically modified (GM) Plants. Blackwell Science Publications.
3. Karp, G., Cell and Molecular Biology: Concepts & Experiments. 3rd Edition. John Wiley Sons, Inc., N.Y.

ZOL-707 BIOINFORMATICS Cr. Hrs. 3

Course Contents

Introduction to computer hardware and software, computer applications for biotechnologists, Spreadsheet work, Word processing; Graphical and Statistical analysis packages. Biocomputing (Introduction to String Matching Algorithms, Database Search Techniques, Sequence Comparison and Alignment Techniques, Use of Biochemical Scoring Matrices, Introduction to Graph Matching Algorithms, Genome Comparison, Prediction and its Implication). Introduction to Bioinformatics, its Definition and History, Introduction to Data Mining and its Application, Database Hierarchies, Genomic and Proteomic Sequence Database and their Interpretation (UCSC Genome Database, NCBI, PDB, EcoCyc, DDBJ, SWISS-PROT, TIGR, KEGG etc) Bioinformatics Tools: Repeatmasker, PHRED, PHRAP, BLAST, Prosite/BLOCKS/PFAM, CLUSTALW, Emotif, RasMol, Oligo, Primer3, Molscript, Treeview, Alscript, Genetic Analysis Software, Phylip.

Recommended Books (Latest Edition)

1. Higgis, D, Taylor, W. Bioinformatics: Sequence, structure and databanks, Oxford University Press.
2. Westhead, D.R., Parish, J.H. and Twyman, R.M. INSTANT NOTES ON BIOINFORMATICS. Viva Books Private Limited
3. Kanesha, M. Post-genome informatics, Oxford University Press.
4. Pain, R Mechanism of protein folding. Oxford University Press.

5. Misener, Stephen, Ed.; Krawetz and Stephen A. Bioinformatics methods and protocols. Humana Press, Totowa.
6. Baxevanis, A. S. and Quellette, B.F.F. (2001). Bioinformatics: a practical guide to the analysis of genes and proteins. Wiley-Interscience. A John Wiley & Sons.
7. Baldi, Pierre; Brunak, Soren, Bioinformatics: the machine learning approach. Edition 2nd the MIT Press, Cambridge. Bioinformatics; Molecular Biology-Computer Simulation; Molecular Biology-Mathematical Models; Neural Networks 'Computer Science'; Machine Learning; Markov Processes.
8. Pevzner, Pavel A. Computational Molecular Biology: an algorithmic approach the MIT Press, Cambridge.
9. Baxevanic, A.D. and Ouellette, B.F.F. BIOINFORMATICS: A Practical Guide to the Analysis of Genes and Proteins, O'Relilly Publlishers.
10. Moody, G. Digital code of life: how bioinformatics is revolutionizing science, medicine and business. 2004. John Wiley and Sons.
11. Orengo, C. A., Jones, D.T. and Thornton, J .M. Bioinformatics: genes, proteins and computers (Advanced Text) Roultledge.
12. http://www.ncbi.nlm.nih.gov
13. http://www.ebi.ac.uk
14. http://foldoc.doc.ic.ac.uk/foldoc/index.html
15. http://wit.integratedgenomics.com/GOLD/

ZOL-708 CANCER GENETICS Cr. Hrs. 3

Course Contents

Cancer definition. Genetic basis of cancer. Oncogenes and Tumor Suppressor Genes. Cell Cycle Control Genes. Growth Regulatory Genes. Genes involved in Repair pathways. Cancer and Genetic Susceptibility. SNP and Cancer. Genetic Screening for Cancer. Case Studies: P53. Rb. BRCA1, RRCA2.

Recommended Books (Latest Edition)

1. Articles Published in Nature Review Cell & Molecular Biology.
2. Articles Published in Nature Review Immunology.
3. Bruce Alberts, Essentials of Cell Biology.
4. Stryer, Biochemistry
5. Lewin, Genes VIII.

Z00-709 SYSTEMIC TOXICOLOGY Cr. Hrs. 3

Course Contents

Brief introduction to the principals of distribution. Excretion & absorption of toxicants. Biotransformation of toxicants & chemical carcinogens. A detailed study of

the Toxic responses of various systems of the body like Toxic responses of blood, Immune system, Liver, Kidney, Respiratory system, Central Nervous system & Cardiovascular system. Role of free radicals in Toxicity. Modes of Cell death Necrosis & Apoptosis; Cytokines and Signal Transduction.

Recommended Books (Latest Edition)

1. Hayes, A. Wallace, Principles and Methods of Toxicology, Raven Press, New York.
2. Klaassen, C. D., Casarell and Doull's Toxicology; The Basic science of Poisons (International). McGraw-Hill, Health Professions Division, New York.
3. Timbrel, J.A., Introduction to Toxicology, Taylor and Francis Ltd. London.

ZOL-710 FUNDAMENTALS OF MICROBIOLOGY Cr. Hrs. 3

Aims and Objectives

This course is intended to realize the importance of microbiology in different fields of life. The course describes historical roots of the subject as well as the present status of the information ranging from viruses and bacteria to eukaryotic microorganisms.

Course Contents

The scope of microbiology. Microbial evolution, systematic and taxonomy; Characterization and identification of microorganism.Morphology and fine structure of bacteria: Size shape and arrangement of bacterial cells, Flagella and motility, Pili, Capsules, sheaths, Prosthecae and stalks, structure and chemical composition of cell wall cytoplasmic membrane, protoplasts, spheroplasts, the cytoplasm, nuclear material. The cultivation of bacteria: Nutritional requirements, nutritional types of bacteria, bacteriological media, physical conditions required for growth, choice of media, conditions of incubation. Reproduction and growth of bacteria: Modes of cell division, New cell formation. Viruses; Bacteriophages and phages of other protists. Replication of bacteriophages. Viruses of animals and plants; History structure and composition; classification and cultivation of animal viruses. Effects of virus infection on cells. Cancer and viruses. Pure cultures and cultural characteristics: Natural microbial populations, selective methods; Chemical methods, Physical methods, biological methods, Selection in nature, Pure cultures; Methods of isolating pure cultures, Maintenance and preservation of pure cultures, Culture collection, Cultural characteristics: Colony characteristics, Characteristics of broth cultures. Eukaryotic Microorganisms.

Recommended Books (Latest Edition)

1. Benson, H.J. Microbiology, WMC Brown Publisher, England.
2. Madigan, M.T., Martinkom, J.M. and Parker, J. 1 Brock Biology of Microorganism,. Prentice Hall, London.

3. Stainier, R.Y., Ingraham, J.L. Wheelis, M.L. and Painter, R.R. The Microbial World, Prentice Hall, London.
4. Microbial Applications (complete version) Laboratory Manual in General.

ZOL-711 BIOLOGY AND CONTROL OF VERTEBRATE PESTS
Cr. Hrs. 3

Aim and Objectives: The aim of this course is to familiarize students with major vertebrate pests of Pakistan/AJK and methods to control their population and loss

Course Contents

Introduction. General characteristics of pests. Identification and biology of important vertebrate pests. Methods of studying pests population. Methods of damage survey and damage assessment. Diseases carriers and public health importance. Control: Habitat manipulation and ecologically based integrated management, biological control, non-chemical/physical controls. Chemical Control; laboratory and field evolution of pesticide and materials, field application of pesticides baits. Evolution of control. Justification and ecological consideration.

Recommended Books (Latest Edition)

1. Singelton, G.R., Hinds, L.A., Levis, H. and Zhang, Z. Ecologically-based management of rodent pests. Australian Centre for International Agricultural research, Canberra.
2. Buckle, A.P. and Smith, R.H. Rodent pests and their control. CAB international, UK.
3. Books, J.E., Ahmad, E., Hussain, L., Munir, S. and Khan, A.A. A training manual on vertebrate pest Management. A GOP/ USAID/DWRC Vertebrate pest control project, NARC, Islamaabad.
4. Chitty, D. and N.H. Southeren, The control of rats and mice. Vol. I, II, III. Calarendon Press, Oxford.
5. Murton, R.K. and E. N . Wright, The problems of birds as pests. Academic Press, New York. Dermott, W., Mammals and Birds Pests. Ministry of Agriculture, Fisheries and Food. Agricultural Science Service, London.

ZOL-712 FISH PHYSIOLOGY AND BREEDING Cr. Hrs. 3

Aims and Objectives

The aim of this course is to provide sufficient knowledge about all physiological phenomena in fishes. The subject provides practicals information to obtain better growth by following physiological aspects during extensive or semi-intensive culture. It also emphasizes thoroughly in breeding of most culturable freshwater fished by

manipulating reproductive and endocrinological aspects during natural season as well as off seasons.

Course Contents

Fish nutrition: Digestive system; Stomachless fishes; Stomached fishes; Digestion and absorption; Food; Plant origin; Animal origin; Feeding; Fresh food; Dry concentrates; Pelleted food. **Transportation:** Blood; Blood cells (Erythrocytes, leukocytes, Platelets and plasma); Circulation; Arterial system; Venous system; Capillaries; Transport of food material. **Respiration:** Gills; Lungs; Skin; Swimbladder; Homeostasis. **Excretion:** Kidneys; Hypo-osmotic urine; Hyper-osmotic urine; Osmoregulation. **Reproduction:** Gonads; Testes and ovaries; Maturation; Reproductive cells (egg and sperm); Artificial fertilization of sex cells. **Breeding:** Natural (seasonal); Artificial; Hormonal induced breeding; Temperature & photoperiod; control induced breeding. **Growth:** Extensive culture (due to the consumption of natural food); Semi-intensive culture (due to natural & artificial food); Intensive culture (due to only dry concentrates). **Fish health:** Water quality; Hygiene of fish culture facilities; Hygiene of equipments used in fish culture.

Diseases and their control: Viral; Bacterial; Fungal; Parasitic; Protozoan; Helminths (trematodes, cestodes, nematodes, acanthocephalons); Crustaceans (cladocera); Annelids (leeches); Arthropods (water ticks, water flea, water mites). **Fish migration:** To nursery ground; To maturation grounds; Freshwater to marine water; Marine water to freshwater. **Fish behaviour:** Learning and memory; Light response for maturation; Courtship behaviour; Aquarium fish behaviour.

Recommended Books (Latest Edition)

1. Kestin, S. C. and Warris, P.D. (Editors). Kestin Farmed Fish Quality, Blackwell Science, Oxford, UK.
2. Saksena, D.N. Ichthyology Recent Research Advances. Oscar Publications. India.
3. Woo, P.T.K Fish Diseases And Disorder. Vol 1. Protozoan and Metazoan Infections. CABI Publisher.
4. Brenabe, G. Aquaculture, Vol. I. Blackwell Publishing, Oxford. UK.
5. Maseke C. Fish Aquaculture. Pergamon Press, Oxford. UK.
6. Huet M. Text Book Of Fish Culture: Breeding And Cultivation. 1973. Blackwell Publishing Company
7. Hoars, W.S. Fish Physiology. Academic Press. UK.
8. Matty, A.J. Fish Endocrinology. Timber Press, UK.
9. Gorbman, A. Comparative Endocrinology John Wiley & Sons. UK.

ZOL-713 ADVANCES IN AQUACULTURE Cr. Hrs. 3

Course Contents

Aquaculture: the concept, mariculture; the substrate system, seawater ponds, cages, enclosure, tanks. Aquaculture in fresh and brackish water. Water quality parameters in fish culture. Culture systems (open, semi-closed, closed). Polyculture vs. monoculture. Significance of aeration, culture of molluscs, Crustaceans; Fish (Carp, Trout, Cat fish, Tilapia, Salmon). Aquaculture management (lakes, reservoirs etc.) economics and marketing; feeding for Carp, Salmonids and Cat Fishes. Intensive and semi-intensive culture of major carps.

Recommended Books (Latest Edition)

1. Meade, J.W. Aquaculture Management. Chapmen & Hall Inc. N. York.
2. Pillay, T.V.R., Aquaculture: Principles and Practices. Fishing News Books, London.
3. Parker, R. Aquaculture Science. Delmar Publishers, N. York.
4. Deborah, A. T. Aquaculture, Mansell, N. York.
5. Agrawal, V.V.P. Recent Trends in Aquaculture. Society of Biosciences. India.
6. Roddy, M.S. and K.R.S. Sambasiva, R., A Text Book of Aquaculture. Discovery Publishing House, New. Delhi.

ZOL-714 CONSERVATION BIOLOGY OF WILDLIFE Cr. Hrs. 3

Add aim and objectives: Course intends to teach basic concept of wildlife conservation, assessment of threats (natural and anthropogenic) and their mitigation.

Course Contents

Introduction to conservation biology; species diversity, ecosystem diversity, genetic diversity. Threats to wildlife: mass extinction and global changes, ecosystem degradation and loss, over exploitation, deforestation, fragmentation and reduction in wildlife habitats, island biogeography, exotic species, inbreeding and outbreeding depressions, loss of genetic variability, environmental fluctuations, factors limiting the population size. Human factors; economic factors, politics and actions. The risks faced by small populations, Risk assessment, diagnosis of declines, treatment of declines, and role of economic and trades in wildlife conservation, role of national and international legislation in wildlife conservation. Population genetics, extinction, restoration ecology, management and conservation policy. Conservation through population and ecosystem management. Role of zoos, national parks, sanctuaries and game reserves for maintaining the biological diversity. management and conservation of rare, over-abundant and over-harvested wildlife populations.

Recommended Books (Latest Edition)

1. Caughley, G. and A. Gunn, Conservation biology in theory and practice. Blackwell Science Publication.

2. Eric. G. Bolen and William L. Robinson. Wildlife Ecology and Management. 3rd Edition. Prentice Hall, Upper Saddle River, New Jersey.
3. Hosetti, B. B. and Venkateshwarlu, M. Trends in Wildlife Biodiversity, Conservation and Management. Daya Publishing House Delhi-11035.
4. Malcolm L. Hunter, Jr. Fundamentals of Conservation Biology, Blackwell Science Inc.
5. Mills, L.S. Conservation of Wildlife Populations: Demography, Genetics and Management. Blackwell Publishing, USA.
6. Richard B. Primack. Essentials of Conservation Biology. Sinauer Associates Inc. Publishers, Sunderland, Massachusetts, U.S.A.
7. Soule, M. E. Viable populations for Conservation. Cambridge University Press. Cambridge.
8. Soule, M.E. and B.A. Wilcox. Conservation Biology. Sinauer Associates Inc. Sunderland. Massachusetts.

ZOL-715 WILDLIFE DIVERSITY OF PAKISTAN AND AJ&K Cr. Hrs. 3

Aims and Objectives: The aims of the course are to provide basic knowledge to students about the basic concepts of wildlife diversity in Pakistan and AJ&K perspective, species identification techniques, threatened and endangered species of Pakistan and AJ&K, threats to biodiversity and their mitigation.

Course Contents

Wildlife of Pakistan/AJK, Identification, distribution, status, life cycle, conservation and management of amphibians, reptiles, birds and mammals of Pakistan/AJK. Major threats for wildlife population decline. Philosophy of wildlife conservation. In-situ conservation: Protected Areas (Wildlife Sanctuaries, Game Reserves and National Parks in Pakistan/AJK).. Ex-situ conservation: role of zoos, wildlife parks, etc Wildlife conservation through re-introduction. Sustainability of wildlife populations. Wildlife laws in Pakistan & AJ&K. National and international agencies involved in conservation and management of wildlife.

Recommended Books (Latest Edition)

1. Roberts, T.J., Mammals of Pakistan Ernest benon Ltd, London
2. Birds Mammals, Reptiles Amphibians population censing Techniques.
3. Southwick, C.H Ecology and quality of our environment, D.van nostrand Co. New York.

ZOL-716 ADVANCES IN ENVIRONMENTAL BIOLOGY Cr. Hrs. 3

Course Contents

Nature of Ecology, The earth's life support system, Ecosystem concepts and components, Food chains and food webs, Energy flow in Ecosystem, Primary productivity of ecosystems, Matter cycling in ecosystem (Biogeochemical cycles). Ecological Niche, Major ecosystem of world: Estuarine, Freshwater, Tundra, Forest, Grassland and Desert. Population Ecology: population structure, Factors affecting population growth, Factors controlling population growth. Community Ecology: Size and structure of community. Ecological succession: Communities in transition, Role and interaction of species in the ecosystem, Man and Environment, Impact of human population growth: Air pollution: Atmosphere, Outdoor air pollution, Photochemical and industrial smog, Acid deposition, Global warming, Ozone depletion in the stratosphere, Types and sources of water pollution, Noise pollution.

Recommended Books (Latest Edition)

1. Miller, G.T. 2002. Living in the environment: Principles, Connections and Solution. Thomson Learning, Australia.
2. M.L. Mckinney Environmental Sciense: System and Solution Jones & Bartlett Publication, Boston.
3. M.C. Molles Ecology: Concepts and application WCB/McGraw Hill, New York.
4. Smith Ecology and field biology National Book Foundation
5. E.P. Odum Fundamentals of Ecology.

ZOL-717 FUNDAMENTALS OF BIOTECHNOLOGY Cr. Hrs. 3

Course Contents

The cell, its organelles and their functions, growth requirements, Characteristics and Industrial importance of algae, fungi and bacteria, Glycolytic pathway and enzymes, Fermentative ethanol production, High-energy compounds and coenzymes, TCA cycle and its metabolic and industrial importance, Protein structure, synthesis and function, Nucleic acids and microbial strain selection techniques, Cell growth parameters, Fermentor assembly and systems, cultivation conditions, sterilization and inoculation procedures, Biomass and Single-Cell Protein production. Aerobic and anaerobic yeast fermentations: products & processes.

Recommended Books (Latest Edition)

1. Principles of Plant Biotechnology an introduction to Genetic Engineering in plants. S. H. Mantel, J. A. Mathews, R. A. Mecee, Blackwell Scientific Publication Oxford, London, Boston.

2. Biotechnology in 21st century, Ayyana, C. Mcgraw Hill.
3. Shuler, M.L.and F. Kargi. Bioprocess Engineering, Prentice-Hall, Englewood Cliffs, NJ.
4. Bailey, J.E. and D.F. Ollis. Biochemical Engineering Fundamentals, McGraw - Hill, New York.
5. Recent research and review articles

ZOL-718 INSTRUMENTAL TECHNIQUES Cr. Hrs. 3

Aims and Objectives

This course aims to demonstrate the knowledge and skill to select and use the appropriate spectrophotometric, chromatographic and electrochemical instrumentation for a specific chemical analysis.

Course Contents

UV Spectroscopy/Separations, Quantitative Infrared Spectroscopy, Flame Atomic Absorption Spectroscopy, Direct Potentiometry, Spectrofluorimetry: Determination of Fluid Volumes by Dye Dilution Techniques, TLC: Drug Monitoring Techniques, Column Techniques: Separation of Transition Metal Cations, Gas Chromatography, High Performance Liquid Chromatography, principles of IR-spectrometry and its use for compound identification; understanding of the working mechanism of the basic components of spectrometric and mass-spectrometric instrumentation, Amino acid sequencers, Balances, Bioreactors, Blotting Apparatus, Centrifuges, DNA sequencers, Electrophoration Instrument, Isoelectric Focusing Apparatus, Lyophilizer, Microarray technology, Microscopy, Microtomy, Nuclear Magnetic Resonance Instrument, principles and application.

Recommended Books (Latest Edition)

1. John Wiley & Sons, Chemical Analysis: Modern instrumentation, methods and techniques, Francis Rouessac and Annick Rouessac.
2. Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Brooks Cole, Principles of Instrumental Analysis. ISBN 0-03-002078-6.

ZOL-719 ADVANCES IN DEVELOPMENTAL BIOLOGY Cr. Hrs. 3

Course objective

The wonder of a fertilized egg directing its own development into an adult organism is nearly unfathomable in its complexity. However, recent technological advances have begun to shed light on the fundamental molecular mechanisms that guide development. This course is designed to introduce students to these discoveries.

Course Contents

General Principles: Differential Gene Expression**,** Cell-Cell Communication**,** Principles of Development - Differentiation, Specification, & Cell Lineage.

Reproduction and Early Development: Meiosis – Gametogenesis**,** Fertilization**,** Early Development & Axis Formation – *Drosophila***,** Vertebrates. **Apoptosis-** mechanism and significance, **Ageing-** mechanism, concepts and models. **Applied Developmental Biology:** Assisted Reproduction & Hormonal Regulation, Multiple ovulation and embryo transfer technology (MOET), Pluripotent Stem Cells: ES Cells and iPS Cells Application of embryonic stem cells, clinical and economic significance, Embryonic sexing, cloning, screening for genetic disorder diagnosis (ICSI, GIFT etc.), Cloning of animals by nuclear transfer. **Mammalian development and medical embryology*:*** Early Development of the Mammalian Central Nervous System**,** Early Musculoskeletal Development**,** Limb Patterning and Development**,** Development and Birth Defects of the Eye and Ear**,** Development of the Heart**,** Development of Lungs and Aortic Arches**,** Development of the GI & Renal Systems**,** Sex Determination**,** Gonadal Development**,**Neural Crest & Craniofacial Development.

Recommended Books (Latest Edition)

1. Leon W. Developmental Biology. 2nd Edition. Browwer Saunders College publishing.
2. Current Topics in Developmental Biology eds. R. A. Pedersen and G. P. Schatten.
3. : S. C. Goel, Principles of animal developmental biologyHimalaya Publishing House.
4. S.F. Gilbert. Developmental Biology. Sinauer Associates Inc. Publishers.
5. D. A. Ede. An Introduction to Developmental Biology:
6. Principles of developmental: Paul Weiss edited by Hafner publishing company New York
7. Cells into organs. The forces that shape the Embryo. John Philip Trinkaus ed. Tom Aloisi.
8. Lewis Wolpert et al. Principles of development: Oxford University Press.
9. B. M. Patten & B. M. Carlson. Tata Foundations of Embryology. McGraw Hill Publishing Company Ltd., New Delhi.
10. Balinsky An Introduction to Embryology: (CBS College Publishing).
11. Marshall's Physiology of Reproduction Longmont, Green and Co. London Vol. 1 &2. Lamming

ZOL-720 ADVANCED MEDICAL PARASITOLOGY Cr. Hrs. 3

Aims and objectives

To provide an overview of the major parasitic diseases of man and their vectors prevalent in Pakistan. By the end of these course students should be able to:

1. demonstrate understanding of the biology and the life cycles of the major parasites and of their vectors or intermediate hosts;
2. identify the major parasites, vectors and intermediate hosts;
3. demonstrate understanding of the pathogenesis and pathology of the major parasitic diseases and the immune responses to these parasites;
4. appreciate the epidemiology of the major parasitic infections;
5. Appropriate methods available for chemotherapy and control.

Course Contents

Symbiosis to parasitism: parasite, host, community; Malaria; biological aspects; immunological and patho-physiological aspects in malaria; Leishmaniasis: disease spectra and immunopathology; Chagas' disease; Opportunistic pathogens: Toxoplasmosis; Intestinal protozoa: Amebiasis and Giardiasis; Hepatosplenic, intestinal and urinary schistosomiasis; Fascioliasis; Echinococcosis; Cerebral and generalized cysticercosis; Ascariasis and visceral larva migrans; Intestinal nematodiasis: immunological mechanisms of worm expulsion; Cytokines: their roles in parasitic diseases; Lymphatic filariasis; Trichinosis; Significance of eosinophilia in helminthiasis. Parasite-host cell molecular interaction.

Recommended Books (Latest Edition)

1. L.S. Roberts and J. Janovy Jr., Foundations of Parasitology by McGraw Hill, Boston.
2. P.C. Beaver and R.C. Jung. Animal Agents and Vectors of Human Diseases.
3. Strickland G. T. Hunter’s Tropical Medicine.
4. Janeway, C.A. and Travers, P. Immunobiology

ZOL-721 ADVANCES IN REPRODUCTIVE PHYSIOLOGY Cr. Hrs. 3

Aims and Objectives

The aim of the subject is to learn about the advanced techniques in reproductive physiology. In addition it includes the biosynthesis and action of reproductive hormones and the dysfunction of reproductive organs that illustrate the basic principles of normal physiology.

Course Contents

Hypothalamus– Anatomy, cytoarchitecture, Releasing and release inhibiting hormones. Neurotransmitters and neural signals, Feedback regulatory mechanism, Adenohypophysis: Anatomy, cytology, Neurohypophysis: Anatomy, cytology, Gonadotrophic hormones: structure, mechanism of secretion and function. Anatomy and hormones: Hypothalamo – hypophyseal testis axis, The Androgen: Biosynthesis, mode of action, transport and functions of testosterone, Physiology of inhibin-biosynthesis, mode of action and functions, Hypothalamo – hypophyseal thyroid-gonad axis, Hypothalamo – hypophyseal ovarian axis, The oestrogen : Biosynthesis, mode of action, transport and functions, The progesterone: Biosynthesis, mode of action, transport and function, Hypothalamo-hypophyseal adrenal-gonad axis. Spermatogenesis: Process, hormonal control and ultra-structure of spermatozoa, Mechanism of oogenesis: Process, biochemical events, hormonal regulation. Fertilization: Cytological and molecular events of fertilization, Types of cleavage, blastulation, gastrulation and embryonic induction. Male accessory sex glands in mammals: structure, secretion and functions, Semen- biochemical composition and sperm abnormality. Sperm capacitation and decapacitation- molecular mechanism and significance. Pheromones and sexual behavior in mammals: Molecular induction (Morphogenetic gradients) and organizer concept, Cryopreservation of gametes, embryo and test-tube baby. In vitro fertilization (IVF) and its significance.

Recommended Books (Latest Edition)

1. Martin H. Johnson and Barry J. Everitt. Essential Reproduction. Blackwell Science.
2. Current Topics in Developmental Biology eds. R. A. Pedersen and G. P. Schatten.
3. S. C. Goel, Principles of animal developmental biology: Himalaya Publishing House.
4. S.F. Gilbert. Developmental Biology, 9th Edn. Sinauer Associates Inc. Publishers.
5. B. M. Patten & B. M. Carlson. Foundations of Embryology. Tata McGraw Hill Publishing Company Ltd., New Delhi.
6. Balinsky An Introduction to Embryology (CBS College Publishing).
7. Austin and Short, Embryonic and foetal development. Cambridge University Press
8. Green and Co. London Vol. 1 & 2. Marshall's Physiology of Reproduction. Lamming, G.E. (Ed).

ZOL-722 RECOMBINANT DNA TECHNOLOGY Cr. Hrs. 3

Course Contents

Introduction and History of Recombinant DNA technology, structure of chromosomes and Genes, Function of DNA and RNA, classes of RNA, Nucleotide units of DNA and RNA, DNA as storage of Genetic information, Basic techniques of rDNA technology, Blotting techniques, restriction endonucleases, restriction mapping, vectors and their types, cloning and expression vectors, expression systems, transformations, Polymerase Chain Reaction, Cloning strategies, Site-directed

mutagenesis. Sequencing strategies, Application of recombinant DNA Technology (agriculture, health, industry, environment and basic research). Isolation of DNA from prokaryotes and eukaryotes, Advantages and steps making cDNA, Methods of cDNA libraries development/screening, Introduction to identification of recombinant clones, E. coli expression system, Gene expression system in yeast, Concept so cell lines, gene expression systems in human and animal cell lines, Retroviral and other viral vectors for plants and animals.

Recommended Books (Latest Edition)

1. Robert F.W. Molecular Biology. McGraw-Hill.
2. Dale, J.W. and von Schantz, M. From Genes to Genomes: Concepts and Applications of DNA Technology. John-Wiley and Son Limited.
3. Meyers, R.A. Genomics and Genetics. John-Wiley and Son Limited.
4. Primrose, S.B., and Twyman, R.M. Gene Manipulation and Genomics Blackwell Publishing.
5. Watson, J.M., Caudy, A.A., Meyers, R.A., and Witkowski, J.A., Recombinant DNA. Gene and genomes..W.h. Freeman and Company, New York.

ZOL-723 **ADVANCES IN MICROBIOLOGY** **Cr. Hrs. 3**

Course Contents

Types of micro-organisms. Theory of microorganisms: Microorganisms and diseases Pathogenecity of microorganisms, Human air, food and water borne infections and their control Contact diseases of animals. Host-microbe interactions, Resistance and immunity, Fundamental of control, control by physical and chemical agents. Antibiotics and other chemotherapeutic agents. Microbial toxins and their role in the pathogenecity of disease. Mechanism of pathogenecity caused by microbial toxins. Pathogenesis of cholera, typhoid, diphtheria and septicemia. Environmental and industrial Microbiology. Microbiology of air, water and food. Microbiology of milk and milk products.

Recommended Books (Latest Edition)

1. Pelczar Jr., Chan,E.C.S. and Krieg, M.R., Microbiology,McGraw Hill,London.
2. Peltler., G.L.A Laboratory Manual of Microbiology.
3. Pelczar Jr., Chan,E.C.S. and Krieg, M.R. Concepts and Applications.

Web References

1. http://gsbs.utmb.edu/microbook/toc.html
2. http://www.biosci.ohio-state.edu/-mgonzalez/micro521.html
3. http://bioweb.uwlax.edu/Genweb/Microbiology/General/general.html
4. http://www.medunich.edu/TAMC/LINKS.HTML
5. http://acs.ucalgary.ca/-browder/transgeni.html

ZOL-724 WILDLIFE CONSERVATION OF PAKISTAN AND AZAD JAMMU & KASHMIR Cr. Hrs. 3

Aims and Objectives: The course intends to teach basic knowledge to students about the conservation of wildlife especially in Pakistan and AJ&K. and their mitigation. It also provides the knowledge about the threatened and endangered species of wild animals, threats and their management principles and efforts being made at global in general and regional level in specific.

Course Contents

Definitions, concepts and importance of wildlife. Classification of the amphibians, reptiles, birds and mammals of Pakistan/AJK up to Orders with identifying characteristics and examples. Status and distribution of the wildlife of Pakistan/AJK. Species status assessment system of IUCN - global and national. Extinct/extirpated wildlife of Pakistan/AJK, with their causes of extinction. Threatened wildlife of Pakistan/AJK and their threats. Different types of wildlife habitats in Pakistan/AJK (Alpine, sub alpine, forests, wetlands, village groves, cultivations, grasslands, deserts, etc.). Wildlife conservation: Ethics of conservation, priorities in conservation effort, ex-situ and in-situ conservation, conservation and rural development, role of culture and religion in conservation, National Conservation Strategy of Pakistan/AJK. Participatory management of wildlife. Captive breeding and re-introduction of wildlife. Cage/fencing, habitat preparation and maintenance of wildlife for captive breeding. Zoos and Safari Park in Pakistan/AJK. Human-wildlife conflict in Pakistan/AJK and its mitigation (snake bite, crop damage by bears and macaques, poultry damage by wild cats and jackals, human and cattle deaths by leopards, etc.). Laws and conventions related to wildlife: Pakistan/AJK Wildlife Act, Convention on Biological Diversity (1992), Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973), Ramsar Convention (1971). National and international organizations involved in wildlife conservation.

Recommended Books (Latest Edition)

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

8. Jordan, E. L. and Verma, P. S. Invertebrate Zoology, S. Chand and Company.
9. M.S. Khan. . Amphibians and Reptiles of Pakistan. Krieger Publishing Company, Florida USA.
10. M. M. Shafique, Wildlife Acts and Rules of Pakistan. PFI, Peshawar.
11. Miller and Harly, Zoology (7th Edition). McGraw Hill, New York.
12. Mirza, Z. B. Illustrated handbook of Animal Biodiversity of Pakistan. Printopak.
13. Mitsch, W. J. and Gosselink, J. G. Wetlands 4th ed. John Wiley & Sons, Inc.
14. Punjab Wildlife Act 1974. Government of the Punjab.
15. Roberts, T. J. Birds of Pakistan. Vol. I Oxford University Press
16. Roberts, T. J. Birds of Pakistan. Vol. II. Oxford University Press
17. Roberts, T. J. Field Guide to the large and Medium-sized Mammals of Pakistan. Oxford University Press
18. Roberts, T. J. Field Guide to the small Mammals of Pakistan. Oxford University Press.

ZOL-725 DIAGNOSTIC TECHNIQUES IN MOLECULAR GENETICS Cr. Hrs. 3

Course Contents

Extraction of Nucleic Acids, Nucleic Acid Blotting Techniques, The Polymerase Chain Reaction, Bioinformatics: Computer-Based Approaches to Genetic Analysis, PCR-Based Methods for Mutation Detection, Electrophoretic Methods for Mutation Detection and DNA Sequencing, Single-Nucleotide Polymorphisms: Testing DNA Variation for Disease Association, Microarray Approaches to Gene Expression Analysis, Alternative Methods for Amplified Nucleic Acid Testing.

Recommended Books (Latest Edition)

1. William B., Coleman, Gregory J. and Tsongalis Molecular Diagnostics For the
2. Wayne W. Grody, M.D., Robert M. Nakamura, M.D., Charles M. Strom, M.D., and Frederick L. Kiechle. Molecular Diagnostics Techniques and Applications for the Clinical Laboratory
3. George P. Patrinos and Wilhelm Ansorge Molecular Diagnostics

ZOO-726 APPLIED AND EXPERIMENTAL STATISTICS Cr. Hrs. 3

Course contents

Importance of statistics in variety of fields including medicine, biological, physical and social sciences, Basic concepts of statistics, frequencies, mean, mode, standard deviation, standard error, range etc. Probability and Normality, Sampling methods, Hypothesis testing, T test (Paired T test, one sample t test), Chi Square test, F test, One way analysis of variance, two way analysis of variance, LSD and DMRT tests, Correlation analysis, simple linear regression analysis, Logistic regression analysis, Odds Ratio. Analysis of given data by T test, Chi square test, Correlation, regression and one way ANOVA applying any of the available statistical software preferably SPSS or R Program

Recommended Books (Latest Edition)

1- Walpole, R E. Introduction to statistics. McMillon Publishing Co New York
2- Muhammad F. Statistical methods and Data analysis. Kitab Markaz, Faisalabad
3- Mariappan P. Biostatistics: an Introduction (LPE). Pearson, New York, New Dehli
4- Forthofer R N. Biostatistics: a guide to design, analysis and discovery. Elsevier Publishers.
5- Montgomery D C Design and Analysis of Experiments. Wiley Publishers, New Dehli.

ZOL-727 COMPARATIVE PHYSIOLOGY Cr. Hrs. 3

Course Contents

Overview of resting membrane potential, action potential and synaptic transmission; Structure and mechanism in ion channels; Biosynthesis of neurotransmitters; Neurotransmitters actions at synaptic receptors. Neurosecretions and neurotransmitters in higher nervous system activity. Molecular mechanisms in transduction of sensory stimuli into impulse; photochemistry transduction of photoreceptor; Color vision, Overview of endocrine glands, their hormones and roles; Chemistry and biosynthesis of hormones of adenohypophysis, and neurohypophysis thyroid, parathyroid, endocrine pancreas, adrenal medulla and steriodogenic tissues; Structure of hormone receptors; Mechanisms of action of a protein/peptide, a steroid and thyroid hormone; Hormonal regulation of metabolism; Molecular basis of muscular contraction; Molecular interaction at neuromuscular level; Molecular structure of cilia and flagella and mechanisms in movements.

Automatcity and rythmicity of myogenic heart; regulation of cardiac activity; Humeral regulation of circulation: Vasoconstriction and vasodilation. Exchange of respiratory gases; Chemical regulation of respiration. Nature and formation of various nitrogenous waste product; Glomerular filteration, Reabsorption and secretion mechanism; Concentration of urine. Regulation of digestive secretions; Digestion and absorption of nutrients. Molecular mechanisms in adaptation to temperature extremes.

Recommended Books (Latest Edition)

1. Randall, D., Burggren, W., French, K. and Femald, R., Eckert Animal Physiology; Mechanisms and Adaptations, 6th ed. W.H. Freeman and Company, New York.
2. Berne, R.M. and Levy, M.N., Principles of Physiology,. St. Lious, Mosby.
3. Guyton, A.C., and Hall, J.E., Textbook of Medical Physiology, W.B. Saunders Company, Philadelphia.
4. Withers, P.C., Comparative Animal Physiology, Saunders College Publishing, Philadelphia.

5. Schmidt-Nelsen, K., Animal Physiology, Adaptation and Environment, Cambridge University Press, Cambridge.
6. Tharp, G. and Woodman, D., Experiments in Physiology, 8th Edition, Prentice Hall, London.

ZOL-728 COMPARATIVE VERTEBRATE ENDOCRINOLOGY Cr. Hrs. 3

Course Contents

General concept in Comparative Endocrinlogy; Comparative Morphology of endocrine tissues in vertebrates; The chemical structure, syntheses, polymorphism and evolution of hormones; the life history of hormones. Hormones and Nutrition; Hormones and the integument; Hormones and osmoregulation; Hormones and reproduction. Roles of hormones in metabolism.

Recommended Books (Latest Edition)

1. Bentley, P.J., Comparative Vertebrate Endocrinology. Cambridge University Press, Cambridge.

ZOL-729 PHYSIOLOGY OF COORDINATION Cr. Hrs. 3

Course Contents

Physiological Mechanisms at Cell: Cellular membrane and transmembrane transport; resting membrane potentials; generation and conduction of action potentials; synaptic

transmission; membrane receptors, second messenger and signal-transduction pathways.

Nervous System: Organization of nervous system: system; general sensory system; visual, auditory, vestibular and chemical sensory system; motor system with brain stem, Cortical, cerebellar and basal ganglia control of posture and movements; Autonomic system and its control; Higher functions of nervous system including state of consciousness, learning and memory.

Muscle and Movements: Molecular basis of contraction; Muscles activity on skeleton; adaptation of muscles for various activities; Muscles in the walls of hollow organs.

Endocrine System: General principles of endocrine physiology; Hormones in homeostasis of metabolism; Endocrine regulation of metabolism of calcium and phosphate; Parathyroid gland, Calcitonin and cholecalciferol; Hypothalamus and pituitary; Hypothalamic regulation of pituitary, Pituitary gland hormone in physiological coordination; Thyroid gland; Functional anatomy, biosynthesis,

regulation and roles in physiological functions, mechanism of thyroid hormones action; Adrenal cortex: Hormones biosynthesis, physiological roles and control; Adrenal medulla: Hormones biosynthesis, physiological roles, and hypothalamic-pituitary-adrenocortical axis, adrenal medulla and stress; Endocrine function of kidney, heart and pineal gland; General reproductive mechanisms: Energetics of reproduction; Functional anatomy,synthesis and regulation of gonadal steroids, at different stage of life; Roles of androgen, Biology and regulation of oogenesis, female puberty, cyclic changes and adaptations in gestation, parturition, lactation and menopause.

Recommended Books (Latest Edition)

1. McArdle, W.D., Katch, F.I. and Katch, V.L., Exercise Physiology, Nutrition and Human Performance, Lippincott, Williams and Wilkins Publishers, Philadelphia.
2. Powers, S.K. and Howley, E.T., 1997. Exercise Physiology: Theory and application to fitness and performance. Brown & Benchmark Publishers, Madison.

ZOL-730 MOLECULAR BIOLOGY OF GENE EXPRESSION AND FUNCTIONS

Cr. Hrs. 3

Course Contents

Nucleosome Structure, Histone Modification and Chromatin Remodeling in gene activation. Epigenetic regulation, Transcriptional regulation of gene expression, Post-transcriptional regulation of gene expression, Regulation of gene expression at protein level, Studying gene expression by using cultured cells, Reporter genes, Transgenic animals, Gene targeting, Knock out mutations.

Recommended Books (Latest Edition)

1. Tom Strachan & Andrew Read Human Molecular Genetics.
2. Bruce Alberts Essentials of Cell Biology.
3. Lewin Genes VIII

ZOL-731 ENVIRONMENTAL BIOTECHNOLOGY Cr. Hrs. 3

Course Contents

Waste treatment: waste water treatment; Solid waste treatment; activated sludge processing, landfill. Biodegradation of pollutants: degradation of chemical pollutants,

e.g., petroleum hydrocarbons, biotransformation (e.g.) heavy metals). Molecular approaches for environmental management: importance of genetic exchange in degradation of xenobiotics, tracking of genes in environment. Transport of pathogens through soil and aquifers and their detection methods;

Biosafety: Regulation, Release of genetically modified organisms (GMOs), possible risk assessment, measurement of genotoxicity. Toxicity of degraded products.

Recommended Books (Latest Edition)

1. Ronald M. Atlas, Bioremediation: Applied Microbial Solutions for Real World Environmental Clinic. ASM Press.
2. Christon J. Hurst Manual of Environmental Microbiology. ASM Press .
3. Laqrence P. Wackett Biocatalysis and biodegradation: Microbial Transformation of Organic Compounds. ASM Press.
4. Derek R. Lovley Environmental Microb-Metal Interactions. ASM Press .
5. Christopher F. Faster and D.A John Wase, John Wase Environmental Biotechnology. John Willey & Sons.
6. Ralph Mitchell Environmental Microbiology. John Wiley & Sons Inc.

ZOL-732 APPLICATIONS OF BIOTECHNOLOGY Cr. Hrs. 3

Course Contents

Health Care: Diagnostics, Antibiotics, Biosensors. Therapeutic agents: hormones, monoclonal antibodies, vaccines. Applications in agriculture & livestock products: Biofertilizers: Crop improvement, Process application: Biotechnology of raw-ore processing (sulfides; carbonates and silicates bioleaching), Accumulation of metals by microbial cells, Biopulping; Biofuels Microbial enhanced oil recovery. Food processing: Production of beer, wine, cheese, bread, SCP, citric acid and amino acids. Enzyme technology: Enzyme characterization and kinetics, traditional industries and associated enzymes.

Recommended Books (Latest Edition)

1. Kreuzer H. and Adrianne Massey Biology and Biotechnology: Science, Applications, and Issues. ASM Press.
2. Olliver B. Petroleum Microbiology. ASM Press.
3. Ghannoum, M. Microbial Biofilms. ASM Press.
4. Bernard R. Glick and Jack J. Pasternak Molecular Biotechnology: Principles & Applications of Recombinant DNA, ASM Press.
5. Judith A. Scheppler, Patricia E. Cassin, and Rosa M. Gambier, Biotechnology Explorations: Applying the fundamentals. ASM Press.

6. ED. I.J. Higgines: D.J. Best & J. Jones Biotechnology: Principles and Applications. Blackwell Scientific Publications.
7. Biotechnology. Special Microbial Processes Vol.6: J.J. Rehm VCH Publishers. .

ZOL-733 POPULATION GENETICS Cr. Hrs. 3

Course Contents

Hardy-Weinberg Equlibrium. Frequencies of genes and genotypes. Change of Gene frequency: migration, mutation, selection. Study of small populations: Change of gene frequency under simplified conditions, less simplified condition, pedigreed population and in breeding; metric characters. Population means, average effects, breeding value, dominance deviation, interaction deviation. Genotypic components of and natural populations. Estimation of inbreeding factors. Compartmentation of variance.

Recommended Books (Latest Edition)

1. Strickberger, M.W. Evolution. Jones and Bartlett published, London.
2. Miller, S.A. and Harley, J.B., Zoology, (International). Singapore: McGraw Hill.
3. Hickman, C.P., Roberts, L.S. and Larson, A., Integrated principles of Zoology, (International) Singapore: McGraw Hill.

ZOL-734 BIOCHEMISTRY OF DRUG ACTION Cr. Hrs. 3

Course Contents

Introduction: Drug sources, drug and active principle, drug development. Principles of drug action: drug receptor binding, types of binding forces, agonist and antagonist, dose response curve, affinity, intrinsic activity, efficacy and potency of a drug, concept of receptor reserve. Drug administration, absorption and distribution: routes of drug administration, intestinal mucosa and blood barriers, bioavailability of a drug, first pass metabolism, drug elimination, blood tissue barriers, binding of drug to plasma proteins. Biotransformation of drugs, drug elimination, cellular and metabolic tolerance to a drug. Drugs acting on the sympathetic nervous system: Structure and function of sympathetic nervous system, adrenoceptor subtypes and catecholamine action, direct and indirect sympathomimetics and Sympatholytics drugs used in hypertension, angina, cardiac arrhythmias and heart failure. Drugs acting on parasympathetic and motor nervous system: Structure and function of parasympathetic and motor nervous system, cholinergic synapse, neuromuscular blocking agents, neuromuscular stimulants, parasympathomimetics, parasympatholytics. Drugs used in hyperlipoproteinemias: lipoprotein metabolism, hyperlipoproteinemias, drug treatment. Drugs acting on the central nervous system: neurotransmission in the brain, dopaminergic and serotonergic synapse. CNS stimulants, CNS depressants, antiepileptics, neuroleptics, antidepressants, opiates,

addiction, Hallucinogens, antiparkinsonians, antiepileptics. Antihistaminergic drugs: Allergans, 1gF, histamine, histamine receptors, asthma, hay fever and anaphylaxis, peptic ulcer, drugs for the treatment. Analgesics and antipyretic analgesics: pain mechanism and pathways, thermoregulation and antipyretics, drugs used for analgesic anti-inflammatory and antipyretic activity. Diuretics: NaCl reabsorption in the kidney, osmotic diuretics, diuretics of the sulphonamide type, carbonic anhydrase inhibitors, loop diuretics, thiazide diuretics, potassium sparing diuretics. Antibacterial drugs: Bacterial infection, bactericidal and bacteriostatic effects, bacterial resistance, inhibitors of cell wall synthesis, inhibitors of tetrahydrofolate synthesis, inhibitors of DNA function, inhibitors of protein synthesis.

Recommended Books (Latest Edition)

1. Hardman, J.G., Limberd, L.E., Molinoff, P.B., Ruddon, R.W., Goodman, L.S. and Gilman, A., Goodman & Gillman's, The Pharmacological basis of Therapeutics,. The McGraw Hill Companies.
2. Smith, C.M. and Reynard, A.M., Essentials of Pharmacology. W.B, Saunders Company.
3. Lullmann, H., Mohr, K., Ziegler, A. and Bieger, D., Pocket Atlas of Pharmacology. Thieme Medical Publishers, Inc. New York.
4. Haleem, D.J., Neurochemistry of Drug Action. BCC & T Press Karachi Univ.
5. Walker, R., Clinical Pharmacy and Therapeutics. Longman Singapore Publishers.
6. Eadie, M.J., Drug Therapy in Neurology. Longman Group UK Limited.
7. Rose, K.M., Rosenfeld, G.C. and Loose-Mitchell, D.S., Pharmacology, William and Wilkings, New York.
8. Rayall, R.W., Mechanism of drug action on the central nervous system. Cambridge University Press.
9. Neal, M.J., Medical Pharmacology at a glance. Blackwell Scientific Publication, Oxford, London.
10. Katzung, B.G., Basic and Clinical Pharmacology. Lange Medical Publications, Califomia.
11. Harvey, R.A. and champe, P.C., Pharmacology (Lippincott, Illustrated Reviews). J.P. Lippincott and Company.

ZOL-735 APPLIED ENTOMOLOGY Cr. Hrs. 3

Course Contents

Introduction; causes of success and economic importance of insects; principles and methods of insect control i.e. cultural, biological, physical, mechanical, reproductive, legislative and chemical. Introduction to IPM (Integrated Pest Management); insecticides, their classification, formulations and application equipment, identification, life histories, mode of damage and control of some of the

important insects such as crops, house hold, stored grains, termites and locust; entomological industries; apiculture, sericulture and lac-culture.

Recommended Books (Latest Edition)

1. Hashmi, A. A., Insect Pest Management, Vols. I, II, III. Pak. Agri. Res. Council, Islamabad.
2. Mathews, G.A., Pesticide Application Methods, 2nd Ed. John Wiley & Sons, Inc. N.Y.
3. P.fadt, E. R., Fundamentals of Applied Entomology 4th Ed. The Macmillan Co., N. Y.
4. Pedigo, L. P., Entomology and Pest Management 4th ed. Prentice and Hall Intl Limited, London.
5. Saha, L. R., Hand Book of Plant Protection, Kalyani Publishers New Delhi.
6. Shah, H. A. and M. A. Saleem, Applied Entomology,. Izhar Sons Printers, Lahore.

ZOL-736 BEHAVIOURAL ECOLOGY Cr. Hrs. 3

AIMS and Objectives

1) To introduce the principles of behavioral ecology in the context of evolutionary mechanisms and a rich description of different animal behaviors.
2) To demonstrate, using examples, how these principles apply to strategies of foraging and predator avoidance, systems of mating and breeding and development of social systems.

Course Contents

Introduction to Ecology and behavior, Inter-relations between behavior and ecology; History of behavioral ecology; proximate and ultimate questions; Genetic and environmental basis of animal behavior; Learning and cognition; Selection, forms of selection; natural & sexual selection; Animal behavioral interactions-competition, parasitism, symbiosis, Predator-prey interactions; Optimal foraging theory; Sociobiology-living in groups and the evolution of altruism, Kin selection; Game theory; Sexual selection: Male and female strategies; Mating system, Mate choice and conflicts; Parental care and parent-offspring conflict; Animal dispersal, migration, and orientation; Animal hibernation; Animal communication; Territoriality – the role of territoriality and communication in foraging, defense and search for mates; Aggression and dominance.

Recommended Books (Latest Edition)

1. Krebs, J.R., and Davies, N.B. An Introduction to Behavioural Ecology. Blackwell Science.
2. Alcock, J. Animal Behavior. 9th ed. Sunderland, MA: Sinauer Associates.

3. Dugatkin, L. Principles of Animal Behavior. New York: W.W. Norton & Co.
4. Dawkins, Richard. The Selfish Gene. Oxford: Oxford University Press.
5. Judson, Olivia. Dr. Tatiana's sex advice to all creation: The definitive guide to the evolutionary biology of sex. United Kingdom: Vintage.

ZOL-737 BIOLOGY OF BIRDS AND MAMMALS OF PAKISTAN & AJK
Cr. Hrs. 3

Course Contents

Structure, origin, evolution, reproduction and life history of birds, iagnost, population regulation, general ecology, geography migration and orientation in birds. Introduction to classification, classification of avifauna of Pakistan. Characteristics, distribution, classification, reproduction and development, iagnost, population and economic relationship of mammal. The mammal fauna of Pakistan and its scientific and economic importance.

Recommended Books (Latest Edition)

1. Bearman, M. and Madge, S., The Handbook of bird identification for Europe and the Western Palaearctic. Princeton Univ. Press, New Jersey.
2. Brook, M. and Birkhead, T., The Cambridge Encyclopedia of Ornithology. Cambridge University Press, Cambridge.
3. Grimmett, R., Inskipp, C. and Inskipp, T. Birds of the Indian Subcontinent. Christopher Helm Pub., London
4. Kroodsma, D.E. and Miller, E.H., Ecology and Evolution of Acoustic communication in Birds. Comstock Pub. Assoc., London.
5. Mock, D.W., Behaviour and evolution of birds. Freeman & Co., New York.
6. Svensson, L., Identification guide to European Passerines. Naturhistoriska Riksmuseet, Stockholm.
7. Rand, A.L., An Introduction to Ornithology. W. W. Norton & Company Inc., N.Y.
8. Roberts, T.J., Birds of Pakistan. Vol. I & II. Oxford University Press, Karachi.
9. Bird life introduction, Birds threatened birds of Asia. The Birdlife International Red Data Book. Cambridge (Part A – Part B).
10. Wallace, G.J. and Mahan, H.D., An Introduction to Ornithology. Macmillan Publishing Company, N.Y.
11. Bibby, C., Jones, M. and Mahan, S., Expedition field techniques: Bird surveys. Birdlife international, Cambridge.
12. Donald, R.G., Bird Migration. Doubleday & Co., N.Y.
13. Khan, A.A., Bibliography of the birds of Pakistan. Ornithological Society of Pakistan, Dera Ghazi Khan.
14. Pettingill, Jr. and Olin Sowall, A laboratory and field manual of Ornithology.

15. Davis, Principles of mammals.
16. Gelder, Biology of mammals.
17. Miller and Harly, Zoology
18. Hickmen, Roberts, and Larsen, Integrated principles of Zoology
19. Cockrum, E.L., Introduction to Mammals. Ronald Press Co., New York.

ZOL-738 PRINCIPLES OF WILDLIFE MANAGEMENT Cr. Hrs. 3

Aims and objectives

The objective of this course is to equip the students with the basic knowledge of wildlife and its interaction to the nature, threats to wildlife and the tools and techniques used in wildlife management to mitigate threats and wildlife conservation.

Course Contents

History and basic concepts in management of wildlife resources i.e. Ecology, Population Dynamics, Biology, Conservation. Wildlife Ecology (Habitat factors & analysis, Ecological Succession and Wildlife, Weather, Climate and Wildlife). Population Dynamics (population analysis and manipulation, carrying capacity, perennial patterns of abundance). Wildlife Biology (wildlife and soils, food, nutrition and water requirements, cover requirements, movements, reproduction, iagnost and physiology, mortality). Wildlife conservation (resource conservation and quality of life, values). Wildlife management (data bases requirements, applications of ecological principles, Art of wildlife management, Administration, participatory management and public awareness). Eco tourism / wild life tourism, Human-Wildlife conflict and Management.

Recommended Books (Latest Edition)

1. Bailey, J.A. Principals of Wildlife Management. John Wiley London.
2. Gilbert, F. F. and D. G. Dodds, The Philosophy and Practice of Wildlife Management. Robert E. Kreiger, Publishing Company, Malabar, Florida.
3. Giles, Jr. R. H. Wildlife Management. W. H. Freeman and Company, San Fransisco.
4. S. K. Singh, Text Book of Wildlife Management. International book distribution Co. India.
5. Peine, John D. Ecosystem Management for Sustainability: Principles and Practices. CRC Press.
6. Scott, Conservation of Biological Diversity; Perspectives and the Future for Wildlife Profession. Wildlife Society Bulletin.
7. Tiwaei, P.C. and Bhagwati, J. Wildlife in the Himalayan Foothills: Conservation and Management.

ZOL-739 ADVANCES IN IMMUNOLOGY Cr. Hrs. 3

Course Contents

Interferons, cytokines, Types of interferon, Viral induction of interferons, Pharmaceutical uses. Apoptosis; caspases, apoptosome. Adaptive (acquired) Immunity, naturally acquired immunity, artificially acquired immunity, active immunity, passive immunity, Adaptive immunity, humoral immunity, cell-mediated immunity, Antigens, Antibodies, Antibody classes, Properties of Antibodies, Opsonization, Immediate (type I,II &III) hypersensitivity, Antibody diversity, Affinity maturation, Affinity and avidity, Antigen and Antibody Interactions, Immunodiffusion reactions, Mancini Radial Immunodiffusion, Rocket electrophoresis, Agglutination Reactions, Radioimmunoassay, Enzyme-Linked Immuno-Sorbent Assay, elispot elisa, Western Blotting, Flow cytometry and fluorescence, B cell development, Cells of cellular response, T cell receptor, T cell Development, The major histo-compatibility complex, cell – cell communication, Tolerance, Immunity to infection, The Immediate defence systems, Complement, Phagocytes, Early Immune responses, Late Immune responses, immune response to vaccines, Immunologic Memory, B-cell memory, T-cell memory, adjuvants, Virosomes, booster doses, Types of Vaccines, Autoimmunity, Allergy, Inflammation, Transplantation, Tumor Immunology.

Recommended Books (Latest Edition)

1. Richard A Goldsby, Thomas J. Kindt. Kuby Immunology. 2006.
2. Alfred I. Tauber. Metchnikoff and the origins of immunology.
3. Alfred I. Tauber. The Immune Self.

ZOL-740 INDUSTRIAL AND PHARMACEUTICAL MICROBIOLOGY Cr. Hrs. 3

Aims and Objectives

To enable students to understand the microbial processes applicable in industries and scale-up processes.

Course Contents

History and chronological development of industrial microbiology. Industrially important strains; Isolation and preservation. Inoculum development for various fermentation process. Strain development; mutation, recombinant DNA technology and plasmid fusion. Fermentation; submerged and solid state fermentation. Components of CSTR; types of feremntors (Tower, cylindroconical and airlift), batch fermentation, continuous fermentation. Downstream process; intrarcellular and extracellular product separation. Liquid extraction, precipitation and floatation. Fermentor design, body construction, mass transfer, oxygen transfer, effect of viscosity,scale-up process. Production of beverages, beer and wine, vitamin B12, and Riboflavin, antibiotics; penicillin and streptomycin, production of enzymes; amylase and proteases and immobilization techniques. Single cell protein, baker's yeast,

spirulina, red algae, and details of mushroom development. Clinical uses of antimicrobial drugs, Microbial spoilage and preservation of pharmaceutical products, Sterilization of pharmaceutical products, Applications of microorganism in the pharmaceutical sciences. Role of precursors and steering agents in production of antibiotics, vitamins and enzymes. Antiseptics, disinfectants their standardization and quality control of pharmaceutical products.

Recommended Books (Latest Edition)

1 Michael J Waites. "Industrial Microbiology, Blackwell Publishing. UK.

2 Shuler, M.L. and F. Kargi. Bioprocess Engineering, basic concepts". Pearson Education, New Delhi.

3 Mansi, EMT. And C.F.A. Bryce. "Fermentation Microbiology and Biotechnology". Taylor and Francis, New York.

4 Hugo, W.B. and Russell, A.D. "Pharmaceutical Microbiology", Publisher Blackwell Science Ltd.

ZOL-741 MEDICAL BIOTECHNOLOGY Cr. Hrs. 3

Course Contents

The role of medical biotechnology, Medical biotechnology; an interdisciplinary pursuit, Scope for use, Public perception, Medical biotechnology and developing world. General principles and strategies for cloning, Cloning tools, The enzymology of *in vitro* DNA recombination, Vectors used for cloning, Sythesis of DNA for cloning, Reaching the gene via mRNA and protein, Synthesis of complete gene, Reporter genes, Recombinant virus genes, The determination of base sequence in DNA(brief account). Spectrophotometeric and UV spectroscopic analysis of nucleic acids, Agarose gel electrophoresis, Pulsed/field gel electrophoresis, Hybridization, Foot printing, Reverse transcriptase, Site directed mutagenesis, Restriction fragment length polymorphism (RFLP), 2 – dimensional gel electrophoresis. DNA finger printing, Enzyme linked immunosorbant assay (ELISA), Diagnostic Polymerase chain reaction (PCR), Types of Polymerase chain reaction, Optimization of PCR conditions, Rapid amplification of cDNA ends (RACE), Other applications of PCR, Gene therapy. Applied medical biotechnology: Pharmaceutical and biopharmaceuticals, Vaccines and monoclonal antibodies, Preparation of monoclonal antibodies, Applications of monoclonal antibodies, Study of new drug targets: Screening of antibiotics, Mode of action of selected antibiotics, Human insulin, Human growth hormone, Factors vm, Lymphokines (Interferon, interleukins) Somatostatin, Bovine growth hormone, Erthropoietin, Epidermal growth factor, Bone growth factors; Other proteins and other products: Tissue Plasminogen Activator (TP A), Human lung surfactant, Artial natriuretic factor, Tumor necrosis factor; Ceredase, Cancer. Biosafety Regulation: Introduction to genetically manipulated organisms (GMOs), Release of genetically engineered

microbes in the environment, Biosafety management, Debate on the safety work in medical biotechnology.

Recommended Books (Latest Edition)

1. Biosafety management .Mitchell, R. Virginia Polytechnic Institute
2. Publication. USA.
3. Molecular cloning (A laboratory manual).Sambrook, J., Fritsch, E. F. and Maniatis, T. Cold Spring Harbour Laboratory Press, UK.
4. Inns, M. A., Gleaned, D. H., Sninsky, I. and White, T. J. PCR-Protocols (A guide tomethods and applications). Academic Press, UK.
5. Doyle, A., Hay, R. and Kirsop, B. E. Living resources for biotechnology. Cambridge University Press, Cambridge, UK.
6. Murray Moo, Y. Animal biotechnology. Pergamon Press Oxford, UK.
7. Gene cloning and manipulation. Howe, C. Cambridge University Press, Cambridge, UK.
8. Understanding DNA and gene cloning. Drlica, K. John Wiley & Sons Inc. USA.
9. Principles of tissue Engineering. Lanza, R.P., Langer, R. and Vacanti, 1. Academic Press, California, USA.
10. Recombinant DNA Vaccines: Rationale and Strategy. Isaacson, R. E. Marcel Dekker, Inc, New York, USA.
11. Hartwell, L.H., Hood, L., Goldberg, M.L., Reynolds, A.E., Silver, L.M. and Veres, R.C. Genetics: From Genes to Genomes. McGraw-Hill Companies, Inc. Avenue of Americans, New York.
12. . Griffiths, A. J. F., Wessler, S.R., Lewontin, R.C. and Carroll, S. B. Introduction to Genetic Analysis Freeman and company, USA, New York.
13. Ed. Ratledge, C. and Kristiansen, Bjorn. Basic Biotechnology. Cambridge University Press, New York.
14. Nicholl, D.S.T. Introduction to Genetic Engineering. Cambridge University Press, New York.
15. Primrose, S.B. and Twyman, R. M. Principles of Gene Manipulation and Genetics. Blackwell Publishing, USA.

ZOL-742 MICROBIAL GENOMICS Cr. Hrs. 3

Aims and Objectives

To enable the students to understand the basic and applied aspects of microbial genomics

Course Contents

Genome Mapping: Genome size-complexity, structure and function of prokaryotic and eukaryotic genome. Physical mapping of genome-Sequencing whole genome, Restriction mapping – FISH, STS mapping, Hybridization assays , Physical mapping without cloning Mapping by genetic techniques, DNA markers: RFLPs, SSLPs, SNPs. Sequencing methods and Strategies: Basic DNA sequencing , Modifications of

chain terminator sequences, Automated DNA sequencing, DNA sequencing by capillary array electrophoresis, shotgun sequencing Overlapping clone contigs, High throughput sequencing strategies, Alternative DNA sequencing, EST sequencing and sequence skimming. Genome Analysis: Overview of sequence analysis, Gene prediction, Tools for genome analysis. Detecting open-reading frames-using homology to find genes, software programs for finding genes Identifying the function of a new gene, Analyses not based on homology, Genome annotation, Molecular hylogenetics. Comparative Genomics : Comparative genomics of prokaryotes, organelles, eukaryotes and other aspects. Representational difference Analysis of cDNA and Genome Comparisons, Gene Expression during Host-pathogen interactions, genomics of *Mycobacterium tuberculosis*, *Helicobacter pylori*. Approaches to bacterial mRNA extraction and labeling for microarray Analysis. Functional Genomics: DNA micro array, Construction and Design, Application of DNA micro array for comparative and Evolutionary Genomics. Gene silencing, RNAi, SiRNA, SHRNA-Proteome analysis, Protein-protein Interactions. Application of Microbial Genomics, Reverse Vaccinology: from genome to vaccine, Microbial genomics for Antibiotic Target Discovery.

Recommended Books (Latest Edition)

1. Pina Faramico, Yanhong Liu, Sophia Kathariou Genomes of food borne and water borne pathogens ASM Press Washington DC
2. Fraser, C. M., T. D. Read and K. E. Nelson Microbial Genomes, Humana Press, USA .
3. Thomas J. Dougherty, Steven J. and Projan Microbial Genomics and Drug Discovery CRC Press.
4. Brendan Wren, Nick Dorrell Functional Microbial Genomics, Methods in Microbiology, Academic Press, UK.
5. Sandy B. Primrose Richard M. Twyman Principles of Genome Analysis and Genomics, Blackwell Publishing, USA.

ZOL-743 PRINCIPLES AND KINETICS OF TOXICOLOGY Cr. Hrs. 3

Aims and objectives

The course provides knowledge and understanding about the nature and mode of action of different categories of toxicants. They will also learn about the procedural protocols used in toxicological studies. The will be enabled to understand the differential effects of variety of toxicants on different cellular sites.

Course Contents

Measuring toxicity and assessing risk: Introduction; chemistry of toxicants; toxicity testing methods; routes of exposure; determining the responses to varying doses of substances; time of exposure; the LD50 experiments; toxicity, hazards and

risks. Toxicokinetics: Introduction; pharmacokinetics and toxicokinetics; absorption: the oral, respiratory and dermal route of exposure, distribution, elimination, toxicokinetic models: mathematical models of elimination; absorption and bioavailability; contrasting kinetics of lipophilic substances. Biotransformation: Introduction; Primary biotransformation (phase I reaction) Hydrolysis, oxidation, reduction, Secondary metabolism (phase II reaction) Glucuridination, Glutathione conjugation, acetylation and other phase Ii reactions, factors influencing metabolism. Cellular sites of action: Introduction, interaction of toxicants with proteins, effect of toxicants on enzymes, receptors and ion channels, voltage activated ion channels and transport proteins;, Effects of toxicants on lipids and nucleic acids, Mechanism of cell death; apoptosis, necrosis, stress, repair and recovery.

Recommended Books (Latest Edition)

1. Karen E. Stine and Thomas M. Brown, Principles of Toxicology, CRC press, Taylor and Francis Group.
2. Hans Marquardt, Siegfried, G. Schafer, Roger Mcclellan, Frank welsch, Toxicology,Academic press, San Diego.
3. Frank A. Barile, Principles of toxicology testing, CRC Press Taylor and Francis Group.
4. M. Lois Murphy, C. P Dagg and David A. Karnofsky, Comparison of teratogenic chemicals in the rat and chick embryos. *Pediatrics*, 19:701-714.

ZOL-744 REGULATION OF GENE EXPRESSION Cr. Hrs. 3

Course Contents

Nucleosome Structure, Histone Modification and Chromatin Remodeling in gene activation. Epigenetic regulation, Transcriptional regulation of gene expression, Post-transcriptional regulation of gene expression, Regulation of gene expression at protein level, Studying gene expression by using cultured cells, Reporter genes, Transgenic animals, Gene targeting, Knock out mutations / Knock in mutations.

Structure and function of RNA molecules. The role of RNA in coding and transferring genetic information, RNA molecules as catalyst in biological systems, RNA-Protein Interactions, Regulation of RNA expression, RNA editing, Functional nucleotides. Modification in RNA, Splicing and self-splicing in RNA.

Recommended Books (Latest Edition)

1. Tom Strachan & Andrew Read, Human Molecular Genetics.
2. Bruce Alberts, Essentials of Cell Biology.
3. Lewin Genes VIII.

ZOL-745 PROTECTED AREAS MANAGEMENT, ECOLOGICAL RESTORATION AND SUSTAINABLE DEVELOPMENT Cr. Hrs. 3

Aims and objectives

The course will:

1. Enable the students to identify the main candidates of ecological restoration (wetlands, lakes, rivers, forests, etc) for conservation.
2. Help the students to understand approaches for conservation such as designing and management of protected areas.
3. Make the students able to play the role of an active conservation biologist.

Course Contents

Protected Areas: definition, existing protected areas categories in Pakistan, IUCN PA categories, values and significance of protected areas, Basis for establishment of nature reserves, Designing protected Areas: Reserve size, minimizing edge and fragmentation effects, Habitat corridors, Landscape ecology and Park design. Managing protected areas: Habitat management, Park management and local community. Management of wildlife outside protected areas: Ecosystem management. Restoration ecology: Restoration ecology in practice. Main candidates for ecological restoration: Wetlands, , urban areas, Prairies, Tropical dry forests, etc. Restoration ecology and the future of conservation. Government action: local legislation, national legislation. Role of NGO's in promoting alliances and collaborative management of Pas. Ramsar sites and special Pas. Traditional societies and sustainable development; Conservation ethics of traditional societies, Local people and their governments, Biological diversity and cultural diversity, Conservation efforts involving traditional societies. International approaches to conservation and sustainable development: The Earth summit, Funding sustainable development programmes, International funding, Funding in developing countries, International development banks and ecosystem damage. An agenda for the future. The role of conservation biologist.

Recommended Books (Latest Edition)

1. A Primer of Conservation Biolog. Primack, R. B. Sinauer Associates Inc. Publishers Sunderland, USA.
2. Biogeography: An ecological and evolutionary approach. Cox, C. B. and Morre, P. D. Life Sciences King's College London, UK.
3. Illustrated Handbook of Biodiversity of Pakistan. Mirza, Z. B. Printopack. Rawalpindi, Pakistan.
4. Biodiversity An Introduction. Gaston, K. J. and Spicer, J. I. Blackwell Science Ltd. UK.
5. Environmental Science: System and solution. McKinny, M. L. and Schoch, M. R.Jones and Bartlett Publications, USA.
6. Pakistan Manual of Plant Ecology.Hussain, S.S. National Book Foundation, Pakistan

7. The Biosphere. Bradbury, I. K. John Wiley and Sons Inc.UK.
8. Tolton, S. and N. Dudley. Partnerships for Protection: new strategies for planning and management for protected areas. James & James/Earthscan
9. Walkey, M., I. R. Swingland and S. Russell. Integrated Protected Area Management. Springer.

ZOL-746 BIOLOGICAL TOXICOLOGY Cr. Hrs. 3

Aims and Objectives

The course provides knowledge and understanding about the different carcinogenic, mutagenic and teratogenic agents and their mode of action and the effects of different chemicals on living cell. They will also learn about the role and mode of action of different toxicants on different organ systems.

Course Contents

Reproductive toxicology and teratology: Effects of toxicants on male and female reproductive system; protective mechanisms, interference with cell division, cytotoxicity and infertility, interference with hormonal control. Effects of toxicants on development; teratogens and teratogenesis, effects of dose exposure level and timing of exposure, examples and mechanism of teratogenity. Respiratory Toxicology: General principles for the effects of toxicants on the system, defense mechanism, measuring the exposure levels, deposition of gases and particulates. Immediate response to respiratory toxicants; free radical induced damage, the irritant response, involvement of immune response. Immediate response; upper and lower airways. Delayed and cumulative response to toxicants; asthma and immune- related chronic condition, COPD; bronchitis and emphysema; fibrosis and pneumoconiosis, lung cancer. Cardiovascular Toxicology: Effects of toxicants on heart; arrhythmias, cardiomyopathies and other effects, myocardial infarction. Effects of toxicants on the vascular system; Atherosclerosis, vascular spasm and blood pressure. Effects of toxicants on blood; anemias, hemolysis and related disorders and effects on hemoglobin. Neurotoxicology: general principles of effects of toxicants, BBB. Effects on electrical conduction, synaptic function (acetylcholine, Biogenic amines, aminoacid neurotransmitters and neuroactive peptides), axonopathies (axon transport, proximal and distal axonopathies), myelinopathies, direct effects on neurons; excitotoxicity, other neurotoxicants. Hepatic Toxicology: Types of toxicant induced injury; fatty liver, necrosis and apoptosis, cirrhosis and miscellaneous effects. Response to liver injury. Renal Toxicology: General principles of effects on the system; damage to glomerulus, proximal and remainder of the tubule. Measurement of kidney function *in vivo* and *in vitro.* Immunotoxicology: Effects of toxicants on immune system; toxin-induced allergies, autiimmunity and immunosuppression. AIDS and antiviral drugs.

Recommended Books (Latest Edition)

1. Karen E. Stine and Thomas M. Brown, Principles of Toxicology, CRC press, Taylor and Francis Group.
2. Hans Marquardt, Siegfried, G. Schafer, Roger Mcclellan, Frank welsch, Toxicology, Academic press, San Diego.
3. Frank A. Barile, Principles of toxicology testing, CRC Press Taylor and Francis Group.
4. M. Lois Murphy, C. P Dagg and David A. Karnofsky, Comparison of teratogenic chemicals in the rat and chick embryos. *Pediatrics*, 19:701-714.

ZOL-747 ENZYME TECHNOLOGY Cr. Hrs. 3

Course Contents

Introduction and principles of enzymology; Enzyme discovery; Classification and nomenclature; Biochemistry of enzymes (Amino acid and protein structures, Forces that maintain protein structures); Introduction to isoenzymes, Allosteric enzymes, Multienzyme complexes and multifunctional enzymes; Mutations, recombination and cloning procedures for enzyme biosynthesis; Industrially important enzymes (brief introduction, chemistry, properties and utilization of amylases, cellulases, proteases etc); Up-stream processing of enzymes; Downstream processing (recovery, fractional precipitation, adsorption column chromatography etc), Physio-chemical properties of enzymes (effect of temp, substrate & pH); Thermodynamics of substrate catalysis; Kinetic and thermodynamic analysis of enzyme stability; Kinetic mechanism of enzyme Inhibition/Activation (Competitive, uncompetitive, and non-competitive); Catabolite repression and feedback inhibition; Enzyme engineering (chemical modification, enzyme immobilization, site directed mutagenesis); Ribozyme and catalytic antibodies; Protein sequencing by Edman Degradation; Effects of organic solvents on enzyme catalysis and structural consequences.

Recommended Books (Latest Edition)

1. Milton H Saier Jr. (Latest Edition)Enzymes in Metabolic Pathways: A Comparative Study of Mechanism, Structure, Evolution, and Control.Harper and Row, New York.
2. P. C. Engel Enzymology: LabFax (The LABFAX Series).
3. Enzyme Biotechnology.
4. R. Eisenthal and M. Danson (Eds) Enzyme Assays: A Practical Approach (The Practical Approach Series) Oxford University Press
5. Gordon F. Bickerstaff Enzymes in Industry and Medicine (New Studies in Biology) Cambridge University Press
6. Enzymes and Immobilized Cells in Biotechnology (Biotechnology Series).
7. Enzymes and Their Inhibition: Drug Development (CRC Enzyme Inhibitors Series)

8. Enzyme Kinetics and Mechanism: Part E (METHODS IN ENZYMOLOGY)
9. Enzyme Structure (Methods in Enzymology) Volume 131.

ZOL-748 ENVIRONMENTAL HEALTH Cr. Hrs. 3

Aims and Objectives

Information from several scientific disciplines (molecular biology, physiology, pharmacology, toxicology, organic and inorganic chemistry) will be integrated with social and political considerations through analysis of risk assessment as a public policy tool. The applied nature of the course will take the form of a risk assessment evaluation and monitoring.

Course Contents

Fundamentals of environmental medicine with basic terminology, methods and principles in environmental medicine. Fundamentals of medical toxicology with Toxicokinetics, biotransformation, toxicological methods and the dose-response concept. Environmental Health addressing all the physical, chemical, and biological factors external to a person. Mutagenicity of different pollutants in the environment and their risk assessment. Biological, Chemical and Physical environmental factors affecting health.

Recommended Books (Latest Edition)

1. Yassi A, Kjellstrom, de kok T, Guidotti T Basic Environmental Health. Oxford Univ. Press, Oxford.
2. WHO/IPCS Principles and Methods for the Assessment of Risk from Essential Trace Elements. Environmental Health Criteria 228, WHO.
3. Koren, Herman, Michael S. Bisesi. Handbook of Environmental Health. Lewis Publishers.
4. Dade W. Moeller. Environmental Health. 3rd edition. Harvard University Press.
5. IARC Preamble of volume 87 Inorganic and organic lead compounds. IARC Monographs, NO 87
6. William N. Rom, Steven B. Markowitz. Environmental and Occupational Medicine. Published by Lippincott Williams & Wilkins.

ZOL-749 RESEARCH METHODOLOGY AND SCIENTIFIC WRITING

Cr. Hrs. 3

Course Contents

Meaning of research, objectives and significance of research, research processes, criteria for good research, problems encountered by researchers in Pakistan. Defining research problem: Selecting research problem, techniques involved in defining a

problem. Developing hypothesis. Review of literature: Different forms and sources of acceptable data and techniques of acquiring required literature. Research and sampling design: Need for research design, characteristics of a good research design, basic principles of experimental designs, Steps in sampling designs, different types of sampling designs. Data collection: types of data, methods of data collection, processing and analysis of data. Introduction to scientific research projects/funding: Finding financial support and industry partnership. A brief idea about the funding agencies such as HEC, PSF, EU, and USAID.What is the scientific writing? Proposal writing; Synopsis; Thesis; Research article; Review article; Short Report; Project Report; Sections of a research article, abstract, introduction, objective, methodology, results, discussion, conclusion, Acknowledgment, authors contribution, conflict of interest, References. Submitting a manuscript. Concept of plagiarism and its management.

Recommended Books (Latest Edition)

1. Michael P. Marder, Research Methods for Science. Cambridge University Press
2. C.R.Kottari. Research Methodology: Methods and Techniques Ram Printograph. Delhi
3. Robert, A. Day. How to write and publish a scientific research paper.
4. Holmann, H.H. Biological research method. Olvyer and Boyd Ltd.

ZOL-750 FISH BIOENERGETICS Cr. Hrs. 3

Course Contencts

Introduction to energetic and energy budgets. Fish feeds and their nutritional value. Metabolism and growth. Energy of waste products. Ecosystem energetics. Energy and food production. Energetics of Locomotion.

Books Recommended

1. Jobling, M., Fish Bioenergetics. Chapman and Hall, London.
2. Har, W.S., Randall, D.J., and Brett, J.R., Fish Physiology, Vol. VIII. Academic Press, New York.
3. Brafield, A.E. and Llewellyn, M.J., Animal Energetics. Blackie&Sons, Glasgow.
4. Tytler, P. and callow, P., Fish Energetic. New Perspectives. Croom Helm, Beckenham.
5. Pandian, T.J.and vernberg, F.J., Animal Energetics, vol. I&II.
6. Weatherley, A.H. and Gill, H.S., The biology of Fish Growth. Academics Press, London.
7. Rankin, J.C. and Jensen, F.B., Fish Ecophysiology. Chapman and Hall, London. Publishing Co. N. Delhi.

ZOl-751 GIS TECHNIQUES Cr. Hrs. 3

Course contents

Concept of GIS; Introduction to ArcGIS; A brief history of GIS; Arc Catalog functions; Spatial data model; Working with Arc Map; Geo referencing; Editing tools;

Spatial analysis; Use of digital elevation model (DEM); Remote sensing and GIS; GIS Applications in the field of biology; Hand on Exercises

Book Recommended:

1. Andy M. The Esri Guide to GIS Analysis, Volume 1: Geographic Patterns and Relationships.
2. Tasha W. and Shelly S. A to Z GIS: An Illustrated Dictionary of Geographic Information Systems.
3. Roger T. Thinking About GIS: Geographic Information System Planning for Managers.
4. Dave P. (Latest Edition) Building a GIS: System Architecture Design Strategies for Managers.
5. Michael L. and Amy C. (Latest Edition) Getting to Know ArcGIS for Desktop.

ZOL-752 RESTORATION ECOLOGY AND SUSTAINABLE DEVELOPMENT

Cr. Hrs. 3

Aims and objectives

The course will:

- Enable the students to identify the main candidates (wetlands, lakes, rivers, forests, etc) for conservation.
- Help the students to develop approaches for conservation such as designing and management of protected areas.
- Make the students able to play the role of an active conservation biologist.

Course Contents

Conservation at the community level: Protected Areas: Existing protected areas, the effectiveness of protected areas, Establishment priorities for protection, International agreements. Designing protected Areas: Reserve size, minimizing edge and fragmentation effects, Habitat corridors, Landscape ecology and Park design. Managing protected areas: Habitat management, Park management and people. Outside protected areas: Wildlife outside parks, Strategies for success, Ecosystem management. Restoration ecology: Restoration ecology in practice. Main candidates for ecological restoration: Wet lands, Lakes, urban areas, Prairies, Tropical dry forests. Restoration ecology and the future of conservation. Government action: local legislation, national legislation.

Conservation and sustainable development: Traditional societies and sustainable development; Conservation ethics of traditional societies, Local people and their

governments, Biological diversity and cultural diversity, Conservation efforts involving traditional societies. International approaches to conservation and sustainable development: The Earth summit, Funding sustainable development programmes, International funding, Funding in developing countries, International development banks and ecosystem damage. An agenda for the future. The role of conservation biologist.

Recommended Books (Latest Edition)

1. A Primer of Conservation Biolog. Primack, R. B. 2nd ed. Sinauer Associates Inc. Publishers Sunderland, USA.
2. Biogeography: An ecological and evolutionary approach. Cox, C. B. and Morre, P. D. 6th ed. Life Sciences King's College London, UK.
3. Illustrated Handbook of Biodiversity of Pakistan. Mirza, Z. B. Printopack. Rawalpindi, Pakistan.
4. Biodiversity An Introduction. Gaston, K. J. and Spicer, J. I. 15t ed. Blackwell Science Ltd. UK.
5. Environmental Science: System and solution. McKinny, M. L. and Schoch, M. R. 1st ed. Jones and Bartlett Publications, USA.
6. Pakistan Manual of Plant Ecology.Hussain, S.S. 1 st ed. National Book Foundation, Pakistan.The Biosphere. Bradbury, I. K. 1st ed. John Wiley and Sons Inc.UK

ZOL-753 ADVANCES IN PLASMA BIOLOGY Cr. Hrs. 3

Course objectives

- Plasma biology is an emerging multidisciplinary field which correlates biology and other disciplines.
- Plasma biology addresses the fundamental questions regarding the mechanisms of interaction between non-thermal plasma and living organisms.
- Students will learn plasma dose dependent cellular responses and how plasmas of different types are influencing the cellular and microbial communication.

Learning outcomes

- Students will learn recent research trends in plasma biology.
- Students will learn non-thermal plasma generation, composition and applications in biology.
- Students will be able to demonstrate the mechanism of plasma treatment dependent cellular responses and how plasmas of different types are influencing the cellular and microbial communication *in-vitro* and *in-vivo*.

Course contents

Introduction, Plasma history, Types of plasma, Biologically active plasma-generated agents; Plama generated reactive oxygen and nitrogen species (RONS), UV radiations, Ions and Molecules.

Plasma interactions with mammalian, bacterial, fungal cells, and animal models; Cellular redox signaling, Oxidative stress, Cell membrane and transport, Cytoskeleton, Cell organelles; Mitochondria and Nucleus, Apoptosis, Necrosis, Cytokine, Growth factors release, Enzyme, Hormone secretion, Cell proliferation and Cell division, Cell migration, Microbial cell response; Sterilization, Mechanism of inactivation, Peroxidation of phospholipids and polysaccharide, DNA damage and Cell death, Resistant strains and Plasma success, Advances in plasma *in-vivo* studies; Mouse and Pig animal models. Written and oral assignments.

Recommended books

1. Harvey Lodish, Arnold Berk, Chris A Kaiser, Monty Krieger, Matthew P Scott, Anthony Bretscher, Hidde Ploegh, Paul Matsudaira, (2018). Molecular cell biologgy. 6th edition. W.H Freeman and company, New York.
2. Alexander Fridman, Gary Friedman, (2013). Plasma Medicine 1st Edition. . John Wiley & Sons, Inc.
3. Gerald Karp, (2010). Cell Biology. Sixth Edition. John Wiley & Sons, Inc.
4. Online literature survey.

ZOL-754 PLASMA MEDICINE Cr. Hrs. 3

Course objectives

- Plasma medicine is young but fast growing field. This course aims to provide knowledge of biomedical applications of plasma.
- Research conducted around the world over the recent decade demonstrates that plasma can be used for variety of medical applications. Study and further investigations of alternative technologies that may offer enhanced quality of health care at reduced cost, such as plasma technology, will be of immense social and commercial value.
- Plasma medicine can be subdivided into three main fields;
  (a) Direct therapeutic plasma applications
  (b) Plasma based decontamination/sterilization
  (c) Plasma modification of biomedical/ biomaterial surfaces

Learning outcomes

- Students will learn recent advances in plasma medicine.
- Students will learn direct therapeutic applications of non-thermal plasma.
- Students will learn how plasma can be used for sterilization of living and non-living surfaces especially medical equipment and laboratory waste.
- Students will learn applications of plasma in biomaterials surface modification for improvement in biocompatibility and bio functionality.

Course contents

Direct therapeutic plasma applications; General introduction, Plasma, medicine, Medical applications of plasma: Wound and burn healing, Blood coagulation, Plasma application in cosmetic; Plasma for skin rejuvenation and wrinkle treatment, Skin color modulation, Dental care; tooth whitening and root canal sterilization, Advances in plasma cancer therapy, Diabetic control by plasma, Application in gynecology; womb surgery and plasma role in controlling microbial load, post-operative bleeding, swelling, rapid recovery, Plasma based decontamination/sterilization; General

overview of sterilization, Wound sterilization, Medical equipment and laboratory waste disinfection, Air and water decontamination, Sterile packaging. Plasma modification of biomedical/biomaterials surfaces: Surface modification of biomaterials using plasma immersion ion implantation and deposition, Improvement in biocompatibility and bio functionality. Written assignments and oral presentations.

Recommended books

1. Alexander Fridman, Gary Friedman, (2013). Plasma Medicine 1st Edition. . John Wiley & Sons, Inc.
2. Jurgen Meichsner, Martin Schmidt, Ralf Schneider, Hans-Erich Wagner, (2012). Nonthermal Plasma Chemistry and Physics. CRC Pres, Taylor and Francis group.
3. Jörg Friedrich, (2012). The Plasma Chemistry of Polymer Surfaces: Advanced Techniques for Surface Design. First Edition. Wiley-VCH Verlag GmbH & Co. KGaA.
4. Online literature review.

ZOL-755 BIOLOGICAL TOOLS, TECHNIQUES AND RESEARCH DESIGN

Cr. Hrs. 3

Course objectives

- This course aims to demonstrate the knowledge and skills to select and use the appropriate tool and technique according to research design.
- Students will learn how modern day biological studies are carried out using state-of-the-art instruments and assays, how research is designed, data is generated, critically evaluated and analyzed.
- The course also prepares students in report writing, preparing and making scientific presentations and surveying of literature.

Learning outcomes

- Student will be able to review literature, design an effective research plan and will get skills to select appropriate tools according to research design.
- Student will learn how to culture bacterial and mammalian cells in lab and how to perform selected experiments. Student will also learn the techniques involved in wild life and animal research in captivity.
- Students will learn how to collect data, how to organize and interpret graphs, how to write, present and publish the scientific work.

Course content

Biological common tools and instruments; Microscopy, SEM, TEM, FACS, Spectrophotometer, Raman spectroscopy, ELIZA plate reader, Live cell imaging, Circular dichroism, Laminar flow, Autoclave, pH meter, Weight machine, Pipette.

Mammalian cell culture techniques; Origin and principles of cell culture; qualitative characteristics of cell cultures; Cell counting and analysis; Cryopreservation; Cell banking and subculture; primary cell culture techniques; Development of immortalized cell line; Detection of microbial contaminants. Bioassay; testing cell viability, proliferation, staining, cytokines, enzyme activity and enzyme kinetics.

Microbial culture techniques; Requirements for *in-vitro* cultures; nutritional types and media preparation, Methods in microbiology; Isolation and culture of microorganism; physical methods and chemical methods, Culture facilities; sterile techniques, maintenance of pure culture, Culture characteristics; colony appearance, colony forms, colony elevation, colony margins, colony odor, colony color, colony consistency, optical density, Measurement of bacterial growth curve, growth and its parameters, Zone of inhibition and MIC detection.

Wild and captive animal research techniques; Research in wild and captivity; Direct and indirect methods for observing animals, Techniques for wild life marking and tracking, Capturing animal; procedure, prior considerations, Drugs; classes, equipment for drug administration to animal for capturing and emergency. Urban wild life capture and handling; Transport, Housing and caging design, Sampling techniques, Sampling methodology, Designing research ethogram, questionnaire and its practice.

Research planning, design, methodology and scientific write-up; Literature review and time management, Identification of gap in existing knowledge, Research errors and sources, Project planning and practice, Development and selection of ideal plan, Plagiarism management, Experimental design, Deciding on techniques to be employed, Sampling and data collection during class through ethogram, Practice for graph generation and results interpretation, Scientific writing, presentation and publishing process, Ethics and safety measures, Scientific record keeping.

Recommended Books (Latest Edition)

1. Oruc A.Y., (2011) Handbook of Scientific Proposal Writing. Chapman and Hall/CRC Press.
2. Veit R, Bobbs-Merrill, J.C., (1985). Writing, Reading and Research Clifford. Educational Pubications.
3. Leedy P.D, Ormrod J.F., (2009). Practical Research: Planning & Design. Publishers Merrill.
4. Jennie P.M, Penelope E. R., (1998). Introduction to Cell and Tissue Culture; Theory and Technique. Plenum Press, New York.
5. Silvy N. J., (2012). The wildlife techniques manual research. Johns Hopkins University Press; 7th edition, Volume 1, Baltimore. ISBN-13: 978-1421401591.
6. Silvy N. J., (2012). The wildlife techniques manual research. Johns Hopkins University Press; 7th edition, Volume 2, Baltimore. ISBN-13: 978-1421401591.

M. Phil 3rd and 4th Semester

CODE	COURSE	Credit Hrs.
ZOL-7001	Seminar	1
ZOL-7002	Thesis	06

ANNEXURE-VI

CURRICULUM FOR PhD ZOOLOGY

DEPARTMENT OF ZOOLOGY

MIRPUR UNIVERSITY OF SCIENCE & TECHNOLOGY

MIRPUR (AJ&K)

SCHEME OF STUDY FOR PhD.

Scheme of Study for Ph. D

Duration	8-10 Semester
Courses	18 Credits hours minimum
Seminars I	01 Credit
Seminars II	01 Credit
Thesis	50 Credits
Total Credits	70

List of Courses for Ph. D Zoology

CODE	COURSE	CREDIT HRS
ZOL-761	Integrated Biological Resource Management	3
ZOL-762	Project Writing Monitoring and Evaluation	3
ZOL-763	Advances in Molecular Biology	3
ZOL-764	Genomics	3
ZOL-765	Molecular Biology of RNA	3
ZOL-766	Cancer Biology	3

ZOL-767	Oncology and Growth Control	3
ZOL-768	Clinical Microbiology	**3**
ZOL-769	Forensic Science	3
ZOL-770	Plasma Treatment and Laboratory Technology	3

CONTENTS OF ELECTIVE COURSES FOR Ph. D ZOOLOGY

ZOL-761 I NTEGRATED BIOLOGICAL RESOURCE MANAGEMENT Cr. Hrs. 3

OBJECTIVES:
The aim of the course is to provide a thorough understanding of natural and biological resources of Pakistan their sound management, protection, and preservation of the ecosystem.

CONTENTS:
Introduction, Ecological zones of Pakistan**,** Geological History of Pakistan, Nature and Biological resources of Pakistan; their present potentials/ exploration and future management/proposals. Plant, Forest, Wildlife, Insect, Marine, Fresh water, Agricultural, Livestock Biodiversity, Genetic Biodiversity, Access & Benefit sharing of Biological Resources, Biodiversity & Climate change, Biodiversity related International convention, Alien Invasive species, Arrangements of Cross Boundary Movements.

RECOMMENDED BOOKS (LATEST EDITION):

1. Afzal, M and Mufti S. A. 2001. Natural History Research in Pakistan. Published by Pakistan Scientific and Technological Information Centre (PASTIC) Islamabad
2. Mufti, S. A., Woods, C. A. and Hassan, S. A. 1997. Biodiversity of Pakistan. Published by Pakistan Museum of Natural History Islamabad & Florida Museum of Natural History Gainesville
3. Alexandrators, N. 1998. World Agriculture: Toward 2000. Printed by Biddles of Guildford Ltd.
4. Wani, B. A. 1992. First National Report of Pakistan to the Convention on Biological Diversity. Ministry of Environment Gov, t of Pakistan

ZOL-762 PROJECT WRITING MONITORING AND EVALUATION Cr. Hrs. 3

OBJECTIVES:
To understand the concept of effective project strategies and techniques for planning, Preparation, monitoring, evaluation and implementation the monitoring and evaluation systems & plans

CONTENTS:
Definition: Types of projects and hierarchy of approving authorities. Rational, identification: problem perception, acquisition of information, validity of problem. Preparation: Techniques for completion of various project formats, Plan of work, budget consideration. Execution: utilization of budget, hiring of manpower, report preparation, and presentation. Monitoring and evaluation. Post project liabilities: follow up, fate of project capital, human resources and transfer of technology.

RECOMMENDED BOOKS (LATEST EDITION)/LITERATURE:

1. Amir, P. and M. Hussain. (1997). Reference Methods on Project Preparation. FAO/UNDP.
2. Asian Development Bank. (1986). Environment Planning and Management. ADB, Manila
3. CBE Style Manual Committee. (1983). CBE Style Manual. 5th ed. Council of Biology Editors, Inc. Bethesda, MD, USA.
4. FAO. (1986). Guide for Training in Formulating Agricultural and Rural investment Projects. Policy Study and Training Service. Olicy Analysis Div., FAO, Rome.
5. FAO. (1990). Rural Area Development & Planning. ESP /TMAP/4. Policy Study and Training Service. Policy Analysis Di., FAO, Rome.
6. Hussain, M. Ch. (1985). Project Appraisal Monitoring & Evaluation process with special reference to Pakistan. Vol. I, II, III & IV. Royal Book Company
7. Insul, A.D. and C.E. Nash. (1990). Aqua-culture project Formulation, Fisheries Technical paper No. 316, FAO, Rome.
8. Nash, C.E. (1995). Aqua- Culture sector, Planning and Management. Fishing new books. Cambridge
9. Projects Wing, Planning and Development Division, Government of Pakistan. (1991).manual for development Projects.

ZOL-763 ADVANCES IN MOLECULAR CELL BIOLOGY Cr. Hrs. 3

Aims and Objectives

Objective of the course is to impart knowledge about the animal cell and its complex organization of architecture and the unified role it plays for the ultimate sustainability of the organisms. The various ultra-structural, molecular and functional aspects of the cells will be communicated in this course.

Course Contents

Generalized structure of prokaryotic and eukaryotic cell. Nucleus: Chromatin, heterochromatin, euchromatin, chromosome structure with reference to coiling and nucleosome during different phases of cell cycle, DNA physical and chemical structure, Regulation of Gene Expression (enzyme induction, enzyme repression, role of Eukaryotes with reference to elaborate promoter and diverse transcription factors involved, concept of examples of Transcriptional Regulation and Translational Regulation). 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 products), Industry (organic solvents, petroleum industry, ore leaching etc). Nuclear Envelope, Nucleolus, Cytoplasmic Organelle, Membrane system (structural and functional commonalities). Ultra structure, chemical composition and functions of Endoplasmic Reticulum with special reference to their role in protein synthesis and drug metabolism), Golgi Apparatus, Mitochondria, peroxisome, glycoxysome. Plasma membrane and its functions Chemical composition and structure of plasma membranes, cell permeability, active transport, endocytosis, phagocytosis. Cytoskeleton microfilaments, microtubules, intermediate filaments. Cell division; molecular aspects of cell division, cell cycle.

Recommended Books (Latest Edition)

1. De Robertis, E. D. P and De Robertis Jr. E. M. F. Cell and Molecular Biology.8th Edition. Lippincott, Williams and Wilkins Publishers.
2. Karp, G. Cell and Molecular Biology. Concepts and Experiments. John Wiley and Sons Publishers.
3. Lodish, H. Molecular and Cell Biology. W. H. Freeman and Co.
4. Gilmartin, P. M. and C. Bowler. Molecular Plant Biology. Vol 1 and 2. Oxford University Press. UK.
5. Malacinski. G. M. Essentials of Molecular Biology. 4th Edition. Jones and Bartlett Publishers, Massachusetts.
6. Watson J. D. Molecular Biology of the Gene. Pearson Education, Singapore.
7. Weaver, R. F. Molecular Biology. McGraw Hill, St. Louis.

8. Lodish, H., Matsudaira, P., Berk, A., Ploegh, H., Scott, M., Kaiser, C. A., Krieger, M., Bretscher, A., Molecular Cell Biology. W. H. Freeman Company.
9. Gartner, L. P., Hiatt, J. L. and Strum, J. M., Cell Biology and Histology. Lippincott Williams and Wilkins.
10. Walker, D., Cells and Life Processes. Smart Apple Media.
11. Alberts. B., Molecular Biology of the Cell Taylor and Francis, Inc.
12. Pollard, T.D., Lippincott-Schwartz, J., Earnshaw, W.C., Cell Biology: Saunders W. B. Co.
13. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D., Molecular Biology of the cell, Garland Publishing Inc., New York.
14. Damell Jr. J., Lodisch, H. and Baltimore, D., Molecular cell Biology. Lea & Febiger, New York.
15. Karp, J. Cell and Molecular Biology, Concepts And Experiments, Jhon Wiley and Sons, INC.
16. Geoffrey M.C., Robert E.H. The Cell: A Molecular Approach, Sinauer Associates, INC.
17. Karp, G., Cell and Molecular Biology. Concepts & Experiments. John Wiley & Sons, New York.

ZOL-764 GENOMICS Cr. Hrs. 3

Course Contents

Strategies for the systematic sequencing of complex genomes, Genomic features of model organisms, Orthologs, paralogs and evolutionary genomics, Gene duplication and co-option 2R or not 2R: extensive genomic duplications in early chordates, Primate segmental duplications, Comparative genomics and decoding the regulatory genome, *"Evodevo"* (evolutionary developmental biology) and genomics, Classification of vertebrate gene deserts, Expansion of introns in animal genomes.

Recommended Books (Latest Edition):

1) Arthur Lesk Introduction to Genomics by Oxford University Press, USA;
2) Tom Strachan & Andrew Read, Garland Human Molecular Genetics by Science/Taylor & Francis Group;
3) Sean B. CarrollW. W. Endless Forms Most Beautiful: The New Science of EvoDevo and the Making of the Animal Kingdom Norton & Company
4) Eric H. Davidson, The Regulatory Genome: Gene Regulatory Networks in Development and Evolution. Academic Press

ZOL-765 MOLECULAR BIOLOGY OF RNA Cr. Hrs. 3

Course Contents

Structure and function of RNA molecules. The role of RNA in coding and transferring genetic information, RNA molecules as catalyst in biological systems, RNA-Protein Interactions, Regulation of RNA expression, RNA editing, Functional nucleotides. Modification in RNA, Splicing and self-splicing in RNA.

Recommended Books (Latest Edition)

1. Tom Strachan & Andrew Read Human Molecular Genetics.
2. Bruce Alberts Essentials of Cell Biology.
3. Lewin Genes VIII

ZOL-766 CANCER BIOLOGY Cr. Hrs. 3

Course Contents

Cancer Introduction, General features and types of cancer. Carcinogenesis; Mechanisms of Carcinogenesis, Factors involved in Carcinogenesis. Role of cell cycle in carcinogenesis. Cell Cycle regulation. Metastasis or spread of cancers. Role of Proteinases in the spread of cancer. Matrix Metalloproteinases (MMPs), MMP1-13. Tissue Inhibitors of Matrix Proteinases (TIMMPs), Urokinase type plasminogen activator. Angiostatin, Endostatin, FGF, VEGF Kinases, Receptor and their ligands, EGF, TGF. Viral Proteins; FOS, JUN, Myc, Ras. Surrogate cancer Markers; AML, APC, BRCA, Estrogen Receptors Adhesion Molecules & Integrins. Cathepsins. Role of Apoptosis in cancer. Role of Cytokines in regulating carcinogenesis.

Recommended Books (Latest Edition)

1. Zhang, Wei, Genomic and molecular neuro-oncology, Jones and Bartlett Publishers, Boston.
2. Cooper, Geoffrey M. Oncogenes, Jones and barlett Publishers, Sudbury.
3. Clark, Cumy, Hicky, Cancer Biology 1st Edition.
4. Clark Roncolph Lee and Cumley Russell W., & Hickey Robert C. The year Book of Cancer .Year Book Publisher Inc.
5. Robert A,Weinberg , The Biology of Cancer

ZOL-767 ONCOLOGY AND GROWTH CONTROL Cr. Hrs. 3

Course Contents

The Control of cell proliferation in normal cells, cell cycle, establishment of cells in culture, normal/transformed cell lines, growth factor, receptors, Oncogenes. Transduction of mitogenic signals and ras Oncogenes, nuclear Oncogenes and regulation of gene expression and multiple steps involved in malignant transformation, viral origin of cancer-SV40, adenovirus genomes, RNA tumor viruses.

Recommended Books (Latest Edition)

1. Zhang, Wei, Genomic and molecular neuro-oncology, Jones and Bartlett Publishers, Boston.
2. Cooper, Geoffrey M. Oncogenes, Jones and barlett Publishers, Sudbury.
3. Karp, G., Cell and Molecular biology: Concepts & Experiments. 3rd Edition. John Wiley Sons, Inc., N.Y.
4. Vasudevan, D.M.; Sreekumari, S., Textbook of Biochemistry: for medical students, Edition 3rd Jaypee Brothers, New Delhi.

ZOL-768 CLINICAL MICROBIOLOGY Cr. Hrs. 3

Course Contents

Specimens: collection, transport and storage. Prevention and control of laboratory acquired-infections; Investigation of food borne and water borne disease outbreaks; Manual & automated systems for microbial identification, immunoassays for the diagnosis of infectious diseases; Molecular detection and identification of microorganisms. Gram positive cocci – Algorithm for identification of aerobic gram positive cocci; *Staphylococcus* and *Micrococcus*; *Streptococcus; Enterococcus*. Gram positive rods– Algorithm for identification of aerobic gram positive rods *Coryneforms, Listeria, Mycobacterium* and *Nocardia.* Gram negative rods-algorithm for identification of aerobic gram negative rods*; Klebseilla, Salmonella, Shigella, Neisseria, Haemophilus* and *Pseudomonas.* Anaerobic bacteria, algorithm for identification of anaerobic bacteria; *Clostridium.* Algorithms for detection and identification of viruses; HIV, human T cell lymphotrophic virus, Hepatitis A, B, C and D viruses; polyoma viruses, rabies virus, Epstein barr virus, Varicella zoster virus, human cytomegalovirus and respiratory syncytial virus . Algorithms for detection and identification of fungi; *Candida, Cryptococcus, Pneumocystis, Aspergillus, Fusarium* and Other opportunistic fungi; *Histoplasma, Blastomyces*, Antimicrobial agents and susceptibility testing: Antibacterial agents, Mechanism of resistance to antimicrobial agents, Susceptibility testing of fastidious bacteria, Susceptibility testing of anaerobic bacteria, Special phenotypic methods for detecting antibacterial resistance, genetic methods for detecting antibacterial and antiviral resistance gene; Antimycobacterial agents and susceptibility test; Antiviral agents and susceptibility test; Antifungal agents and susceptibility test.

Recommended Books (Latest Edition)

1 Greenwood D Medical Microbiology. I.K. International.
2 Murray PR, Pfaller MA, Tenover FC and Yolken RH Clinical Microbiology. ASM Press.
3 Talaro KP and Talaro A. . Foundations in Microbiology. McGraw-Hill College Dimensi.

4 Willey J, Sherwood L. and Woolverton C Prescott/Harley/Klein's Microbiology, McGraw Hill.

5 Atlas RM Principles of Microbiology. McGraw Hill.

6 Nester E.W, Anderson DG and Nester MT Microbiology. A Human Perspective, McGraw Hill

7 Levinson's Review of Medical Microbiology and Immunology,

8 Harrison's Principles of Internal Medicine,

9 Jawetz, Melnick, & Adelberg's medical microbiology,

ZOL-769 FORENSIC SCIENCE Cr. Hrs. 3

Aims and objectives

Forensic Science is the application of all areas of science to assist law enforcement agencies to detect criminal activity and to support the legal system to make just decisions where scientific evidence is presented in a court of law. During this course the students will be introduced to a wide range of scientific disciplines that are involved in the detection of criminal activity. The will be provided with theoretical and practical training covering crime scene science, toxicology, chemistry and molecular biology.

Course Contents

Introduction: definition, scope, history and development, organization and services of crime laboratory. The crime scene: processing the crime scene, legal consideration at crime scene. Physical evidences: types and significance of physical evidences, forensic data base. Physical Properties, Glass and Soil: the meteric system, physical properties, comparing glass fragments, glass fractures, collection and preservation of glass evidences, forensic characteristics of soil, collection and preservation of soil evidences. Organic Analysis: elements and compounds, selecting of organic techniques, chromatography, spectrophotometry, mass spectrophotometer. Inorganic Analysis: evidence in the assassination of President Kennedy, the emission of spectrum of elements, atomic absorption spectrophotometer. The Microscope: Compound, comparison, stereo, polarizing, micro spectrophotometer, SEM. Drugs: drug dependence, narcotic drugs, hallucinogens, depressants, stimulant, club drugs, anabolic steroid, drug control laws, drug identification, collection and preservation of drug evidence. Forensic Toxicology: toxicology of alcohol, role of toxicologist, techniques used in toxicology, significance of toxicological findings, drug recognition experts. Forensic Serology: blood nature, stain patterns, principle heredity. DNA: The Indispensable Forensic Science Tool: DNA work, replication, recombinant DNA, DNA typing, Mitochondrial DNA, CODIS. Hairs, Fibers, and Paint. Fingerprints. Document and Voice Examination, handwriting. Computer Forensics, internet. The future of Forensic Science.

Recommended Books (Latest Edition)

1. Richard Saferstein, Criminalistics: An Introduction to Forensic Science: International Edition.
2. Jay A. Siegel, Forensic Science. Tylor and Francis.
3. Clifton E. Meloan, Richard E. James, Richard Saferstein, Thomas Brettell Lab Manual for Criminalistics: An Introduction to Forensic Science .

ZOL-770 PLASMA TREATMENT AND LABORATORY TECHNOLOGY Cr. Hrs. 3

Course objectives

- This subject presents technological challenges for developing plasma sources, cellular treatment, measurement of plasma agents and analysis of cellular responses.
- This course will cover the concept of plasma work from lab research work to scientific publication and development of new plasma products in market for bio-medical applications.

Learning outcomes

- Students will learn how to generate plasma, how to tune plasma devices for desired characteristics and how to measure plasma agents in lab.
- Students will learn cell culture techniques, plasma treatment methods and analysis of cellular response.
- Students will understand the process of new promising technology development such as plasma from lab research-to commercial market product.

Course contents

Introduction, Plasma in nature and in laboratory, Designing and alteration of plasma device, Plasma generation and effects of input gases, current and voltages, Plasma generation and diagnostics, Culture techniques; cells and microbes, Plasma treatment methods in-vitro, in-vivo and analysis of cellular response, Direct treatments, Indirect treatments, Required plasma doses, Plasma activated solutions and compounds, Physicochemical parameters of plasma: Measurement of pH, Temperature in biological solutions and culture mediums, Ozone detection in air and measurement of intracellular and extracellular reactive oxygen species (OH, H_2O_2), reactive nitrogen species (NO, NO_2,─ and NO_3─). Critical review and oral presentation of research articles, Plasma journals and publication process. Plasma products and marketing.

Recommended books

1. Fridman A., (2008). Plasma chemistry. Cambridge University Press, New York.
2. Helgason C, Miller C.L., 2004. Basic Cell Culture Protocols. 3rd ed. Humana Press.
3. Davis J.M., (2011). Animal Cell Culture: Essential Methods. Wiley publisher.
4. Haycock J, Ahluwalia A, Wilkinson J.M, (2014). Cellular In Vitro Testing: Methods and
Protocols. CRC Press, Taylor & Francis Group.
5. Fridman A, Friedman G., (2013). Plasma Medicine 1st Edition. . John Wiley & Sons, Inc.
6. Online literature survey.

Ph.D. 3rd and Onward Semesters

CODE	COURSE	Credit Hrs.
ZOL-7998	Seminar-I	1
ZOL-7999	Seminar-II	1
ZOL-8000	Thesis	50

ANNEXURE-VII

TITLES OF THE M. PHIL THESES (SESSION 2014-16) FOR APPROVAL

Roll No	NAME	THESIS TITLE
1	Qudisa Rasib	Epidemiology of Foot and Mouth Disease in livestock Attended at Local Veterinary Hospital Mirpur, Azad Jammu & Kashmir
2	Ameena Ayoub	Assessment of Peste Des Petits Ruminants (PPR) in Goats Attended at Local Veterinary Hospital Mirpur, Azad Jammu & Kashmir
3	Tahira Irfan	Gene Expert Testing of all sputum smear positive Tuberculosis cases presented at Tuberculosis reference laboratory Mirpur, Azad Jammu & Kashmir
4	Farwa Iftikhar	Effect of pH on Heat Tolerance of *Enterococcus* Species.
5	Arfan Saghir	Appraisal of Some Selected Heavy Metals in Ground Water Samples from The State of Azad Jammu and Kashmir (AJ&K), Pakistan
6	Sayyeda Samia	Study of Genes Involved in Hereditary Autosomal Recessive Alopecia
7	Noshaba Malik	Study of Hereditary MR Families from District Bhimber Azad Kashmir
8	Zara Azam Ali	Effect of Temperature on Growth of *Staphylococcus* Species.
9	Aneela Gulnaz.	Linkage Analysis of Families Showing Autosomal Recessive Microcephaly from Sialkot Pakistan.
10	Anum Sabir	Effect of pH and Temperature on The Growth of Clinical Isolates of *E*scherichia *coli.*
11	Aneela Shoukat	Physico-Chemical Contemplation of Ground Water Samples Taken From Selected Area of District Poonch Azad Jammu and Kashmir (AJ&K), Pakistan
12	Misbah Anwar	Effect of salts on growth of *Escherichia coli*
13	Neelam Mazhar	Evaluation of Ground Water Quality in Some Selected Areas of District Mirpur Azad Jammu and Kashmir (AJ&K), Pakistan
14	Saleem-e-Rahmat	Diversity and Antimicrobial Activities of Earthworm Species from Mirpur, Azad Jammu & Kashmir.
15	Madih Mushtaq	Exclusion Mapping of Families Showing Autosomal Recessive Intellectual Disability.
16	Shehrish Nawaz	Molecular Study of Families Segregating Autosomal Recessive Microcephaly

17	Sajida Riaz	Linkage Study of Families Showing Autosomal Recessive Occulocutanious Albinism from District Kotli Azad Jammu and Kashmir.
18	Madiha Aslam	Epidemiology of Scabies and Dermatophytes in Patients attended at Dermatology clinic of District Head Quarter Hospital, Mirpur Azad Jammu & Kashmir
19	Muhammad Sadiq	Estimation of Some Selected Heavy Metals in Ground Water Samples from Northern Punjab, Pakistan
20	Shabnam Riaz	Study of Genes Involved In Hereditary Autosomal Recessive Primary Microcephaly from Kotli Azad Jamuu and Kashmir.
21	Hina Altaf	Appraisal of Ground Water Quality in Some Selected Areas of District Bhimber Azad Jammu and Kashmir (AJ&K), Pakistan

ANNEXURE-VIII

LIST OF EXTERNAL EXAMINERS

LIST OF EXTERNAL EXAMINERS DEPARTMENT OF ZOOLOGY

S.#	Name	Designation	Address
1.	Dr. A.R. Shakoori	National Prof/Director	School of Biological Sciences, University of Punjab, Lahore. Email: arshakoori@sbs.pu.edu.pk
2.	Dr. Abdul Ghaffar	Assistant Professor	Department of Meteorology, COMSAT Institute of Information Technology. Road Chak Shahzad Islamabad. Ph: +92-5190495253, Cell: +92- (0)3215164670 E-mail: aghaffar@comsats.edu.pk
3.	Dr. Abdul Qadir	Associate Professor	College of Earth and Environmental Sciences, University of Punjab, Lahore Pakistan. Cell no. 03005500907, E.mail aqfics@yahoo.com
4.	Dr. Abdul Qayyum Nayyer	Associate Professor (Retd)	C/O Department of Zoology, University of Azad Jammu & Kashmir, Muzaffarabad, AJ&K
5.	Dr. Abdul Rab	Senior Scientific Officer (Retd.)	Agriculture & Fisheries, National Agriculture Research Council, (NARC) Park Road Chak Shahzad Islamabad. Cell: 0321-5074668 E.mail: abdulrab2003@yahoo.co.uk
6.	Dr. Abdul Rauf Janjua	Assistant Professor	Department of Zoology UAJ&K Muzafarabad. Email: itsabdulrauf@gmail.om. Cell: 03214965840
7.	Dr. Abida Arshad	Assistant Professor	Department of Zoology, PMAS-Arid Agriculture University Rawalpindi Cell: +92-333-4191470

			Email: abida.arshad@gmail.com
8.	Dr. Abida Raza	Associate Professor	National Institute of Laser and Optronics (NILOP), University of Agriculture, Faisalabad E-mail: abida@nilop.edu.pk
9.	Dr. Afsar Mian	HEC Professor/Dean (Retd).	c/o Department of Zoology, PMAS, University Rawalpindi Email: afsarmianpk@yahoo.com, Cell #: 0333-9552253
10.	Dr. Akram Shah	Professor/Chairman	Department of Zoology, University of Peshawar, KP. Cell: +92-3339247725 Email:akram_shah@uop.edu.pk , akramkokab@yahoo.com
11.	Dr. Alamdar Hussain	Assistant Professor	Department of Biosciences, COMSATS University Islamabad, Pakistan. Cell: 03004420633 Email: alamdarbaloch@gmail.com
12.	Dr. Aleem Ahmed Khan	Professor	Department of Zoology, Gazi Univeristy, Dera Ghazi Khan Cell: +92 300 6352017 Email: hod.zool@gudgk.edu.pk, aakhan@gudgk.edu.pk
13.	Dr. Amina Zabari	Assistant Professor	Department of Animl Sciences, Quaid-e-Azam University, Islamabad. Tel: +92-51 9064-3199. Email:amina.zuberi@qau.edu.pk
14.	Dr. Arif Nadeem Saqib	Senior Research Officer	Pakistan Medical Research Council Islamabad : Ph: 051-9207386 Email; arif289@gmail.com
15.	Dr. Arshed Makhdoom Sabir	Programme Leader	Rice Research Institute (RRI), Kala Shah Kaku, 17 Km G.T. Road Lahore Pakistan, Cell no. 03216135484, E.mail: amsabir@yahoo.co.uk
16.	Dr. Asif Mir	Assistant Professor	Department of Bioinformatics & Biotechnology, International Islamic University (IIU), Islamabad Cell:03111777592, Email: asif.mir@iiu.edu.pk
17.	Dr. Asma Gul	Assistant Professor	Department of Biosciences International Islamic University Islamabad. Phone Office: +92 51 9019 837 Email: gulasma@iiu.edu.pk
18.	Dr. Audil Rasheed	Assistant Professor	Department of Environmental Sciences, PMAS Arid Agriculture University, Rawalpindi. Phone #: +92-51-9290058 audil@uaar.edu.pk
19.	Dr. Azeem Khalid	Professor/Chairman	Department of Environmental Sciences,

			PMAS Arid Agriculture University, Rawalpindi. Phone #: +92-51-9290058 azeemuaf@yahoo.com, azeem@uaar.edu.pk
20.	Dr. Azhar Rasul	Assistant Professor	Department of Zoology, GC University Faisalabad. Email: sul@gmail.com, Mobile: 03218409546
21.	Dr. Basharat Ahmed	Associate Professor/Chairman	Department of Biotechnology, University of Azad Jammu & Kashmir, Muzaffarabad, AJ&K Cell: 03464365411, Email: kbamaknoo@yahoo.com
22.	Dr. Basharat Ahmed	Associate Professor (Retd)	C/O Department of Zoology, Mirpur University of Science and Technology (MUST), Mirpur, Azad Jammu and Kashmir.
23.	Dr. Bashir Ahmad	Professor/Dean	Faculty of Life and Environmental Sciences, University of Peshawar. Phone:091-9216683 Email: dean_les@uop.edu.pk, bashirdr2001@yahoo.com
24.	Dr. Bashir Ahmed	Assistant Professor	Department of Bioinformatics & Biotechnology, International Islamic University Islamabad. Phone Office: +92 51 9019 837 Email: bashir.ahmad@iiu.edu.pk
25.	Dr. Fariah Hasan	Associate Professor	Department of Microbiology Quaid-e-Azam University Islamabad. Ph: 92-51 9064-3065 Email: farihahasan@yahoo.com
26.	Dr. Farzana Perveen	Assistant Professor	Department of Zoology, Shaheed Benazir Bhutto University (SBBU), Main Campus, Sheringal, Khyber Pakhtunkhwa (KP), Pakistan Tel: +021-944885529, Cell: 0300-2253872, Email: farzana_san@hotmail.com
27.	Dr. Fazal Hadi	Assistant Professor	Department of Biotechnology/Botany, University of Malakand, Chakdara, Dir (L) Khyber Pakhtunkhwa, Pakistan. Email: dr.fhadi@uom.edu.pk fazalbiotech@yahoo.com Office Ph.+92-945-763441-42-ext-3019, Cell. +92-347-6873779
28.	Dr. Ghazanfar Ali	Assistant Professor	Department of Biotechnology UAJ&K Muzafarabad. Cell: +923455269635 Email: muzammilgandapur1983@gmail.com

29.	Dr. Gul Naz	Assistant Professor	Department of Biosciences International Islamic University Islamabad. Email: gul.naz@iiu.edu.p Phone Office: +92 51 9019 302
30.	Dr. Haroon Ahmed	Assistant Professor	Department of Bio Science , University, Islamabad Campus Cell: 0345-5162128 Email: haroonahmed@comsats.edu.pk
31.	Dr. Iftikhar Hussain	Professor (Retd)	c/o Department of Wild Life Management, PMAS, Arid Agriculture University, Rawalpindi.
32.	Dr. Jawad Hussain	Assistant Professor	Atta ur Rahman School of Applied Biosciences (ASAB) National University of Science and Technology (NUST) Islamabad Email hassanraja12@hotmail.com mjh@asab.nust.edu.pk Tel : +92 333 5690522
33.	Dr. Khadim Hussain	Assistant Professor	Department of Bioinformatics and Biotechnology, Government College University (GCU) Faisalabad Email: khadim787@yahoo.com
34.	Dr. Luqman Amrao	Assistant Professor	Department of Plant Pathology, Agriculture University, Faisalabad. Cell: 03216696629 Email: raoluqman@gmail.com
35.	Dr. Majid Mehmood	Assistant Professor	Department of Zoology University of Poonch Rawlakot. Email: majidmahmood@upr.edu.pk Cell: 03345289228
36.	Dr. Maqsood Anwar	Professor/ Dean (Retd.)	Department of Wild Life Management Faculty of Forestery, Range Management & Wildlife, PMAS Arid Agriculture University Rawalpindi. Mobile #: 0334-5434784 Email: maqsoodanwar@uaar.edu.pk
37.	Dr. Mazhar Qayyum	Professor	Department of Zoology University of Peer Mehr Ali Shah Aird Agriculture University Rawalpindi Cell # 0300-5317301
38.	Dr. Muhammad Shahid Nadeem	Assistant Professor	Department of Genetics, Hazara University Mansehra Eamil: shaheed_pk1@yahoo.com Ph: +92-997-414131
39.	Dr. Muhammad Akbar Khan	Assistant Professor	Department of Zoology University of the Punjab, Lahore. Email: akbar.zool@pu.edu.pk; akbaar111@gmail.com
40.	Dr. Muhammad	Professor (Retd)	C/O Department of Zoology Panjab

	Akhtar		University Lahore
41.	Dr. Muhammad Ali Nawaz	Assistant Professor	Department of Animal Sciences Quaid-e-Azam University Islamabad. Eamil: nawazma@gmail.com Ph: +92-051 9064-3155
42.	Dr. Muhammad Ansar	Associate Professor	Department of Biochemsitry Quaid-e-Azam University Islamabad. Email: mansar_76@yahoo.com Cell:03215159827
43.	Dr. Muhammad Arshad	Professor/Chairman	Department of Zoology, Sargodha University Sargodha. Email: marshad@uos.edu.pk Phone: +92 48 9230811 - 15 Ext 332
44.	Dr. Muhammad Arshad Malik	Assistant Professor	Department of Biotechnology, International Islamic University Islamabad Ph: +92 51 9019 921 Email: m.arshad@iiu.edu.pk
45.	Dr. Muhammad Faizan Nazar	Assistant Professor	Department of Chemistry, University of Gujarat. Email: faizan_qau@yahoo.com, Mobile: 0301-6942411
46.	Dr. Muhammad Fiaz Khan	Assistant professor/Chairman	Department of Zoology, Hazara University Mansehra. Cell: +92-333-7764446, E. Mail: fiaz_khan88@yahoo.com
47.	Dr. Muhammad Irfan	Assistant Professor	Department of Zoology, PMAS Arid Agriculture University, Rawalpindi. Cell : 03315074475 Email: muhammadirfan11@gmail.com
48.	Dr. Muhammad Ishtiaq Ali	Assistant Professor	Department of Microbiology, Quaid-i-Azam University Islamabad, Pakistan. Office no 051 9064-3196, E. mail Ishi_ali@hotmail.com, isimrl@qau.edu.pk
49.	Dr. Muhammad Jamil Qureshi	Professor (Rtd).	C-9, P.O Box No. 128 Jhang Road. Faisalabad.
50.	Dr. Muhammad Mubin	Assistant Professor	Host-Pathogen Interaction Lab, Centre of Agricultural Biochemistry and Biotechnology (CABB), University of Agriculture Faisalabad Cell: 0300-6615706 Email: mmubin@uaf.edu.pk
51.	Dr. Muhammad Mushtaq	Assistant Professor	Department of Zoology, PMAS Arid Agriculture University, Rawalpindi. Phone : +92-51-9062267 Mobile : +92-300-9867892 Email: mushtaq@uaar.edu.pk
52.	Dr. Muhammad	Associate Professor	Department of Biotechnology QAU

	Naeem		Islamabad. Email: mnaeemqau@gmail.com Cell: 03335324922
53.	Dr. Muhammad Nasim Khan	Professor (Rtd.)	Department of Biotechnology AJKU Muzafarabad. Email: nasimkhan@yahoo.com Cell: 03005599159
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