

**REVISED CURRICULUM
OF
MPhil ZOOLOGY**

2. SCHEME OF STUDIES FOR MPhil ZOOLOGY (TWO YEARS)

Eligibility Criteria: BS (Zoology) with Minimum 2.5 CGPA/ MSc Zoology or relevant field of basic Zoology subjects with Minimum 60% marks.

MPhil Compulsory Courses:

1. Advanced Biological Techniques
2. Applied Biostatistics
3. Seminar

Semester-I

Course Title	Cr hrs
Advanced Biological Techniques (Core Course-1)	3
Optional Course-1	3
Optional Course-2	3
Optional Course-3 (Minor)	3
Total	12

Semester-II

Course Title	Cr hrs
Applied Biostatistics (Core Course-2)	3
Optional Course-4	3
Optional Course-5	3
Optional Course-6 (Minor)	3
Total	12

Semester-III & IV

Course Title	Cr hrs
Thesis	6
Seminar	2
Total	8

- Course work: 24 Cr hrs [18 Cr hrs (Major) + 6 Cr hrs (Minor)] + Thesis: 6 Cr hrs (Compulsory) + Seminar: 2 Cr hrs = Total: 32 Cr hrs
- The minimum and maximum duration of MPhil in Zoology is 1.5 - 4 years from the date of admission.

NOTE: Details of MPhil courses are given in Annex-B.

Department of Zoology
MPhil Courses

Course Code	Title	Cr Hrs
ZOO 601	Advanced Biological Techniques	3
ZOO 602	Applied Biostatistics	3
ZOO 603	Behavioral Ecology	3
ZOO 604	Conservation Biology	3
ZOO 605	Classification of Insect & Pest Management	3
ZOO 606	Environmental Issues	3
ZOO 607	Environmental Pollutions	3
ZOO 608	Introduction to Environment	3
ZOO 609	Insect Toxicology	3
ZOO 610	Medical Virology	3
ZOO 611	Clinical & Diagnostic Virology	3
ZOO 612	Immunology	3
ZOO 613	Anatomy and physiology of amphibians	3
ZOO 614	Anatomy and physiology of reptiles	3
ZOO 615	Herpeto-fauna of Pakistan: ecology and distribution	3
ZOO 616	Advanced systematics and phylogenetic of Herptiles	3
ZOO 617	Molecular GENETICS	3
ZOO 618	Applied genetics	3
ZOO 619	Lab Biosafety and Biosecurity	3
ZOO 620	Research Methods in Entomology	3
ZOO 621	Vector Biology	3
ZOO 622	Insects of Medical Veterinary Importance	3
ZOO 623	Molecular Entomology	3
ZOO 624	Molecular Biology	3
ZOO 625	Overview of Cell Biology	3
ZOO 626	General Toxicology	3
ZOO 627	Fish and Aquatic Toxicology	3
ZOO 628	Fish Parasitology	3
ZOO 629	Fish Processing and Value addition	3
ZOO 630	Fish Nutrition and Health	3
ZOO 631	Vaccines of Human Preventable Diseases	3
ZOO 632	Seminar	2
ZOO 699	Research	6

ZOO 601 ADVANCED BIOLOGICAL TECHNIQUES**3 (3+0)****Course Objectives and Learning Outcomes:****The course aims to:**

1. Familiarize the students with advance biological equipment's and technique
2. Develop basic understanding of the equipment handling in research.
3. Develop scientific and technical expertise, culture and work habits.

After studying this course student must be able to:

- Understand advanced biological techniques
- Apply practical and research skills
- Operate and use the lab equipment efficiently.

Outlines:

UV Spectroscopy/Separations, Flame Atomic Absorption Spectroscopy, Spectrofluorimetry, Thin Layer Chromatography (TLC), Gas Chromatography, High Performance Liquid Chromatography (HPLC), Amino acid sequencing, Blotting techniques, Centrifugation techniques, PCR, DNA Sequencing, Electrophoresis, Isoelectric Focusing Apparatus, Lyophilizer, Microarray Technology, Microscopy, Microtomy, Nuclear Magnetic Resonance Instrument, principles and application, Geographic Information Systems and Remote sensing, ELISA, Cell culture.

Books Recommended:

1. Chemical Analysis: Modern instrumentation, methods and techniques, Francis Rouessac and Annick Rouessac, John Wiley & Sons, 2000, ISBN 0-471-97261-4.
2. Principles of Instrumental Analysis (5th ed), Douglas A. Skoog, F. James Holler and Timothy A. Nieman, Brooks Cole, 1997, ISBN 0-03-002078-6.
3. Spectrometrische analysetechnieken, M.T.C. de Loos - Vollebregt, Heron reeks - Bohn Stafleu Van Loghum, 2004, ISBN 90-313-4142-8.

ZOO 602 APPLIED BIostatISTICS**3 (3+0)****Course Objective**

The aim of this course is to

- Acquaint the scholars with the statistics and use of statistics and its importance in biological experiments.
- It will help in the analysis of the research data, inference and presentation of results and their implications in Biological Sciences.

Course Content:

Introduction to Statistics and Biostatistics, Descriptive and Inferential Statistics, Concept of Probability and Probability Rules, Common Probability, Probability Distributions (Binomial, Poisson and Normal Distribution), Experiment Design, Sampling Methods, Hypothesis testing, t-test, z-test, ANOVA, F-test, Chi-square Test, Regression and Correlation. Use of various statistical software for Data Analysis.

Books Recommended:

1. Field A. (2013) Discovering Statistics with IBM SPSS Statistics. 4th Edition. SAGE Publication Ltd.
2. Belle V. B, Fisher, L.D., Heagerty, P.J., Lumley, T. (2004) Biostatistics – A methodology for the health sciences. 2nd Edition. Wiley-Interscience
3. Quinn, G. (2002) Experimental Design and Data Analysis for Biologists. Cambridge University Press
4. Campbell, M.J., Swinscow, T.D.V. (2009) Statistics at Square One. 11th Edition. BMJ Books.

ZOO 603**BEHAVIORAL ECOLOGY****3 (3+0)****Course Objectives and Learning Outcomes**

The objective of this course is

1. To enable the student to understand not only behavior of animal but combination of behavior and ecology that contribute to reproductive success
2. To understand how animals struggle and survive.
3. To understand difference between survival values on function and those concerned with the casual mechanisms.

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

- Acquire theoretical knowledge of animal behavior, natural selection and evolution.
- Understand the struggle for survival, their ecological relationships
- Solve the survival and breeding related problems which are result of anthropogenic activities.
- Interpretation and synthesis of data and other information about animal behavior, competition and ecological relationships.

COURSE OUTLINE**Animal behaviour and Ecology:**

- a. Introduction
- b. Gene and Behavior
- c. Natural Selection and Behavior
- d. Ecology and Evolution

Hypothesis and Testing

- a. Comparative Approach
- b. Adaptations
- c. Social Organization and Experimental Studies
- d. Economic Decisions Made by Individuals
- e. Marginal Value Theorem and Reproductive Decisions
- f. Economics of Prey Choice
- g. Tradeoff and Optimality Models

Competition for Resources in Individuals

- a. Competition by Exploitation
- b. Competition by Resource Defense

Merits and De-merits of living in Groups

Fighting Among Individuals

- a. Role of Resource Values and Fighting Ability
- b. Fighting for Dominance

Altruism

Kin Selection

Repository and Manipulation in Animals

Division of Labor and Specialized Helpers

BOOKS RECOMMENDED

1. Krebs, J. R. and Davies, N. B., 2007. Behavioral ecology, an evolutionary approach. Blackwell Scientific publication
2. Dugatkin, L. A., 2001. Model System in Behavioral Ecology. Princeton university press.
3. Ridley, M., 1995. Animal Behavior: An Introduction to Behavioral Mechanisms, Development, and Ecology. Blackwell Scientific publication

ZOO 604

CONSERVATION BIOLOGY

3 (3+0)

Course Objectives

The objective of this course is

1. to enable the student to understand and investigate the diversity of living world,
2. to understand the effect of human activities on species, communities and ecosystems; and
3. to develop a practical interdisciplinary approach to protect and restore biological diversity.

Course Learning Outcomes

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

1. ACQUIRE theoretical knowledge about the phenomena that affect the maintenance, loss, and restoration of biological diversity.
2. UNDERSTAND the ecological and evolutionary principles of biological diversity which influence the conservation of wildlife at spatial and temporal scales in Pakistan as well as abroad.
3. SOLVE the conservation issue by applying the scientific principles and modern technologies.
4. ANALYSE, interpreting and synthesize data and other information about the determinants of the conservation problems.
5. EVALUATE the conservation actions taken by the biologists for solving the conservation problems across biological scales (genes to landscapes) and geographical scales (local to global).
6. DEMONSTRATE sound research skills based on ecological and evolutionary principles in investigating problems in conservation biology.

COURSE OUTLINE

Introduction to Conservation Biology:

- a) Definition,
- b) History and
- c) Scope.

Biodiversity:

- a) Species Diversity; Genetic Diversity; Ecosystem Diversity;
- b) Measurement of Biological Diversity;
- c) An Overview of World's Biodiversity;
- d) The Value of Biodiversity

Threats to Biodiversity:

- a) Human Population Growth;
- b) Habitat Destruction; Habitat Fragmentation;
- c) Environmental Degradation and Pollution;
- d) Global Climate Change;
- e) Overexploitation;
- f) Invasive Species

Extinctions:

- a) Extinction and Mass Extinctions;
- b) Rates of Extinction; Island Biogeography;
- c) Vulnerability to Extinction;
- d) Problems of Small Populations; Minimum Viable Population (MVP);
- e) Loss of Genetic Diversity; Effective Population Size;
- f) Demographic and Environmental Stochasticity

Conserving Populations and Species:

- a) Applied Population Biology; Monitoring populations; Population viability analysis; Metapopulations,
- b) International agreements for conservation of fauna and flora; Role of national and International Laws in Protection of Species;
- c) Ex Situ Conservation Strategies; Zoos; Aquariums; Botanical gardens; Seed banks.
- d) Protected Areas and their Establishment and categories;
- e) Managing Protected Areas; Challenges to Protected Areas Management.
- f) Unprotected Public and Private Lands
- g) Ecosystem Management
- h) Integration of Local Community in Conservation
- i) Restoring Damaged Ecosystems

Sustainable Development:

- a) Challenges Involve in Conservation and Sustainable Development at the Local Level
- b) International Approaches to Sustainable Development
- c) Funding for Conservation by the World Bank and international NGOs;
- d) Conservation Education and the Role of Conservation Biologists

TEXT AND REFERENCE BOOKS

1. Richard B. Primack, 2012. A Primer of Conservation Biology; 5th Edition: Sinauer Associates, Inc. Publishers Sunderland, MA U.S.A.
2. Groom, M.J., G.K. Meffe and C.R. Carroll, 2006, Principles of Conservation Biology, 3rd edition, Sinauer Associates, Sunderland, MA.

- l. Order Psocoptera
- m. Order Siphonaptera
- n. Order Zoraptera
- o. Order Megaloptera
- p. Order Raphidioptera
- q. Order Ephemeroptera
- r. Order Odonata

Endopterygota

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

Knowledge of insect pests of

- a. Rice
- b. Cotton
- c. Sugarcane
- d. Wheat

Brief account of different insect pest management strategies as:

- a. Cultural Control
- b. Physical and Mechanical Control
- c. Host Plant Resistance
- d. Biological Control
- e. Chemical Control
- f. Other approaches

TEXT AND REFERENCE BOOKS:

- 1) Atwal, A.S., 2015. Agricultural Pests of Southeast Asia and their Management. Kalyani Publishers, Ludhiana.
- 2) Ambrose, D.P., 2015. The Insects: Structure Functions and Biodiversity. Kalyani publishers, Ludhiana, India.
- 3) Chapman, R. F., 2013. The Insects-Structure and Function. 5th Edition. Cambridge University Press, New York.
- 4) Gullan, P. J. and Cranston, P. S., 2014. The Insects: An Outline of Entomology. 4th edition. Wiley-Blackwell. A John Wiley & Sons, Ltd., Publication, UK.
- 5) Pedigo, L.P. and Marlin, E. R. 2009. Entomology and Pest Management, 6th Edition, Person Education Inc., Upper Saddle River, New Jersey 07458, U.S.A.

ZOO 606

ENVIRONMENTAL ISSUES

3 (3+0)

Course Objectives

The objectives of the course are:-

1. To familiarize the students about the learning and solutions of burning environmental issues
2. To enable the students to understand impact and importance environmental issues for the betterment of the environment
3. To check and control all sources that are destroying natural environment in Pakistan

COURSE LEARNING OUTCOMES:

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

- Acquire the basic knowledge of types of environmental degradation issues
- Understand the concepts of basic issues related environment of Pakistan
- Solve the problems using learned tools for tackling the environmental issues

COURSE OUTLINE:

Human population:

Human population explosion, environmental and social impacts of growing population, its affluences and settlement of population problems.

Human impact on water resources, Eutrophication and its control.

Hazardous Chemicals:

Nature of chemical risks and sources.

Water and land pollution with micro plastics, biodegradable plastic, oxo-degradable plastic its threats and control

Sewage Pollution:

Sprawl and Sewage hazards and sewage managements,

Solid waste:

landfills, incineration, management and solutions

Pest and pest control:

Pest and pest control need and approach to pest control and integrated pest management.

Major atmospheric Changes:

Acid deposition, global warming/ cooling, greenhouse effect, Ozone depletion. smog and PAN, MTBE & CFCs

Environmental Issues in Pakistan:

Ecological issues; soil erosion, deforestation, issues related to irrigation system, natural hazards, issues related to conservation of habitat and biodiversity

Emerging issues; Lead in paint-chemicalproducts, hazardous electrical, nanotechnology, endocrine-disrupting chemicals, pharmaceutical pollutants and per fluorinated chemicals

Energy resources:

Energy sources and uses; issues related to fossil fuel and nuclear power, alternate energy resources.

Nuclear energy, radiation, types, sources, health effects and preventive measures.

Major threats to biodiversity

Major threats to biodiversity in Pakistan, Conservation strategies. Global environmental facility (GEF) **biosafety and its importance**

TEXT AND REFERENCE BOOKS:

1. Environmental Science (Earth as a living planet). 2000. 3rd ed. Botkin, D. B. and Keller, E. A. John Wiley and Sons Inc. New York, USA.
2. Environmental Science (The way the world works). 1998. 1st ed. Nebel, B. J. and Wright, R. T. Prentice Hall International Inc. London, UK.
3. The Biosphere. 1998. 2nd ed. Bradbury, I. K. John Wiley and Sons Inc. UK.
4. Environmental Science (Systems and solutions). 1998. McKinney, M. L. and Schoch, R. M. Jones and Bartlett Publications Inc. USA.
5. Pakistan- A Descriptive Atlas (A comprehensive geo-politics course). 2000. 1st ed. Ahmad, R. Z. Ferozsons Pvt. Ltd. Lahore Pakistan.
6. A Geography of Pakistan Environment (Environment, people and economy). 1993. 1st ed Khan, F. K. Oxford University Press. New York USA.

ZOO 607

ENVIRONMENTAL POLLUTION

3 (3+0)

Course Objectives

The objectives of the course are:-

1. To familiarize the students with the types of environmental pollutants
2. To introduce the students with the ecosystem related pollutant with their origin and mode of action
3. To train the students in tackling the treatments of pollutants

COURSE LEARNING OUTCOMES:

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

1. Acquire the basic knowledge of pollutants nature
2. Understand the concepts of basic techniques and use them efficiently for control of pollutants with their nature
3. Solve the problems of the environment by using different methods

COURSE OUTLINE:

Introduction

- a. Pollution, types, water pollution, water pollutants, category and composition of waste water.
- b. Water quality index. Ground water pollution, Aquifers, Hydraulic gradient,
- c. Darcy's Law, contaminants in ground water, waste water remediation technologies for surface and ground water.
- d. Effect of Water pollution on ecosystem and biota

Water Quality Control:

- a. Introduction, standard qualities for Drinking Water, Water quality standards for irrigation, industry, fishery and other ventures.
- b. Water treatment systems and waste water treatments technologies
- c. Hazardous waste in Pakistan water bodies, solid wastes, sewerage, sewage disposal and treatment

Air Pollution:

- a. Introduction, Pollutant sources, Primary and secondary pollutants and toxic air pollutants.
- b. Air quality standards, motor vehicle emissions and stationary emissions-composition and control.
- c. Formation of aerosol and its effects and indoor air quality standards.
- d. Air pollution assessment technologies and its effect on biota

Soil Pollution and Solid Waste:

- a. Introduction, sources of soil pollutants-municipal, agriculture, aquaculture, poultry and industrial sources of soil pollutants.
- b. Classification, characterization of solid waste, hazardous solid waste and biomedical waste.
- c. Leachate of solid waste, transboundary movement of wastes, physical, chemical and biological treatment of waste
- d. Disposal recycling of solid waste, effect of soil pollution on ecosystem and biota.

Noise Pollution:

- a. Introduction, Noise and vibration, sources of noise pollution,
- b. Noise, health, permissible levels, sonic boom, impulsive noise
- c. Anechoic chamber reverberating sound, noise topography and regulations for control of noise

Thermal and light Pollution:

- a. Introduction, sources of thermal pollution, effect of discharge of heat, effect of thermal pollution and its effect on ecosystem and biota.
- b. Light Pollution, environmental health, effect of light on pollinators and crop yield

Status of Environmental Pollutions in Pakistan:

- a. Prevention and control of wastes and National program to control wastes
- b. Reuse and recycle of waste, Acts and regulation to control pollution.

TEXT AND REFERENCE BOOKS:

1. Gilbert M. Masters and Wendall, P. Ela. Introduction to Environmental Engineering and Science. PHI learning Pvt. Ltd.
2. Khopkar, S. M. Environmental Pollution- Monitoring and Control. New Age International Publishers, New Delhi.
3. William W Nazaroff and Lisa A Cohen. Environmental Engineering Science. Wiley Publishers.

ZOO 608**INTRODUCTION TO ENVIRONMENT****3 (3+0)****Course Objectives**

The course objectives are:

- a. To enable students to understand interrelationship between variousComponents of the environment.
- b. To provide knowledge about basic concepts of matter, energy, birth ofUniverse, solar system and origin of earth.
- c. To provide knowledge about environmental geology and environmentand life and human activity are considered for understanding ofenvironment and its trans disciplinary integration.

COURSE LEARNING OUTCOMES:

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

- a. Discover interrelationship between variousComponents of the environment.
- b. Interpret basic concepts of matter, energy, birth ofUniverse, solar system and origin of earth.

- c. Assess environmental geology and environment and life and human activity for understanding of environment and its trans disciplinary integration.

COURSE OUTLINE

Environment: Introduction and definitions. Environmental systems; Atmosphere, Lithosphere, Hydrosphere, Biosphere, Origin and their interrelationships

Environmental factors: a. Physical, chemical and biological factors.

Variety of life and environment (brief account).

Environment and human interactions. Environmental pollution; types, sources, causes and effects (brief overview).

Environmental issues and challenges: Deforestation, water logging, Salinity, drought and desertification, Loss of natural habitat, Depletion of resources, Population and genetic diversity

Environment and sustainable development

Issues of social environment

- a. Population growth, urbanization
- b. Migration and poverty
- c. Lifestyle and environment.

Text and Reference books:

1. otkin, D. and Keller, E. Environmental Science (Earth as a living planet). 2000. 1st ed. B. John Wiley and Sons Inc. New York, USA.
2. Nebel, B. J. and Wright, R. T. Environmental Science (The way the world works). 1998. 1st ed. Prentice Hall International Inc. London, 1. UK.
2. de Blij, H. J. and Muller, P.O. Physical Geography of the Global Environment. 1993. 1st ed. John Wiley and Sons Inc. New York, USA.
3. Strahler, A. and Strahler, A. 1997. Physical Geography (Science and systems of the human environment). 1st ed. John Wiley and Sons Inc. New York, USA.

ZOO 609

INSECT TOXICOLOGY

3 (3+0)

Course Objectives

The objectives of the course are:-

- To provide theoretical knowledge and introduction to laboratory methods associated with toxicology in insects.
- Scientific evaluation of the effects of interaction of insects with synthetic and naturally occurring compounds can lead to efficient environmentally friendly insecticides. Insecticide resistance, targeted pest control and protection of non-target species are some of the core problems plaguing insecticide use practices.
- To educate about the types of insecticides, their effects on insects and potential strategies for addressing insecticide use issues.

COURSE LEARNING OUTCOMES:

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

1. Evaluate effects of interaction of insects with synthetic and naturally occurring compounds.
2. Practice about the types of insecticides, their effects on insects and potential strategies for addressing insecticide use issues.

3. Operate laboratory methods associated with toxicology in insects.

COURSE OUTLINE:

Introduction to Toxicology

- a. History of Toxicology
- b. Toxic Agents and Substances
- c. Natural and Synthetic Pesticides
- d. Dose and its impact on toxicity

Classification of Insecticides

- a. History and Classification of Insecticides
- b. Chlorinated Hydrocarbon Insecticides
- c. Organophosphorus Insecticides, Carbamate Insecticides, Thiocyanate Insecticides, Dinitrophenols, Fluoroacetate Derivatives, Acaricidal Chemicals, Fumigants, Inorganic Insecticides, Synergists, Hormone Mimics, Cuticle Formation Inhibitors, Microbial Insecticides

Modes and Mechanisms of Action of Insecticides

- a. Insecticide Entry Routes into Insects
- b. Effects on the Insect Nervous System, Electron Transport System, Enzyme Inhibition, Chitin and Cuticle, Behavior Modification
- c. Insect Endocrinology

Evaluation of Insecticide Toxicity

- a. Toxicity Tests against Insects
- b. Methods for Testing Insect Toxicity (Injection, Dipping, Contact, Fumigation and Feeding Methods)
- c. Estimating LD₅₀, Biological and Biochemical Assays, Laboratory Bioassays and Field Assays Ames Test, Comet Assay

Forensic Entomotoxicology

Methods for detection of toxic substances in entomological specimens

Problems in insect Toxicology

- a. Insecticide Resistance
- b. Minimizing Human and Non-Target Species Toxicity
- c. Protecting Pollinator Species
- d. Effects of Insecticides on the Environment and Wildlife
- e. Pesticide Residue in Food and Threats to Domestic Animals

Text and Reference books:

1. Chemical Pesticides: Mode of Action and Toxicology. Stenersen, J. 2004. CRC Press, USA. ISBN 0-7484-0910-6.
2. Toxicology of Insecticides. Second Edition. Matsumura, F. 1975. Plenum Press, New York and London. ISBN 9781461344124.
3. Text Book of Insect Toxicology. Srivastava, R. P. and Saxena, R. C. 1989. Himanshu Publications. ISBN 8185167184, 9788185167183.
4. The Toxicology and Biochemistry of Insecticides. Yu, S. J. 2014. CRC Press. ISBN 9781482210606.

Course Objectives and Learning Outcomes:

The objectives of the course are:-

1. To provide expertise in microbiology, with a particular focus on medical virology.
2. To achieve in-depth knowledge and understanding of medical virology.
3. Develop an understanding of the scientific basis of concepts, as well as practical skills in medical virology.

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

- Understand differences between the lifecycles of major groups of viruses, in particular how different viruses exploit the molecular and cell biology of their hosts.
- Understand the innate and adaptive defenses of mammals against viruses, and the strategies that viruses have evolved to evade these host defenses.
- Understand strategies to prevent (vaccination) and to treat (antiviral therapy) viral infections.

Course Outline:

1. **Introduction to virology:** Introduction of viruses, History of virology, Structure, and classification of viruses, Introduction to laboratory techniques.
2. **The viral replication cycle:** Replication strategies for DNA and RNA genome viruses. Viral receptors, attachment. Entry of enveloped and non-enveloped viruses. Uncoating and disassembly. Structural, Nonstructural viral proteins. Viral genome replication. Assembly and maturation of virions.
3. **Pathogenesis – viral entry, spread, and host response.** Routes of entry and transmission. Tissue tropism, evasion of the host response. Latency, Persistence, transformation. Acute and persistent infections. Transformation, viral oncogenes.
4. **Virus evolution and emerging/re-emerging viral infections:** Variation and viral polymerases. Natural selection, drift vs shift. Recombination and reassortment. Virus-host co-evolution. Emergence and re-emergence.
5. **Transmission:** Transmission strategies. Incubation and generation time. Epidemic and endemic viruses, herd immunity. Detection and Surveillance, eradication and control. Viral vectors and gene therapy.
6. **Detection and prevention:** Eradication of viral diseases. Laboratory methods for detecting and classifying. Techniques for developing viral vaccines. Antiviral therapies.

Recommended Books:

1. Christopher Burrell Colin Howard Frederick Murphy. 2016. Fenner and White's Medical Virology, 5th Edition. Imprint: Academic Press. University of Texas Medical Branch, Galveston, TX, USA.
2. Dorothy H. Crawford. 2011. Viruses: A Very Short Introduction. Publisher Oxford University Press.
3. James H. Jorgensen, Michael A. Pfaller. 2015. Manual of Clinical Microbiology. 11th Edition Publisher American Society for Microbiology. Washington DC, United States.
4. Jawetz, Melnick and Adelberg. 2012. Medical Microbiology, 24th Edition. Prentice-Hall, Upper Saddle River, New Jersey USA.

Course Objectives:

The objectives of the course are:-

1. To communicate knowledge about the clinical aspects of various viral infections.
2. To impart the understanding of diagnostic methods of various viral diseases.
3. To develop critical thinking about the Clinical and diagnostics correlations.

Course Outline:

1. Foundations of Clinical Virology:

Introduction to Viruses: Virus structure, life cycle, Baltimore classification, figures of DNA and RNA virus classification, transmission, nomenclature

Laboratory Diagnosis of Viral Infections

Differential diagnosis for viral syndromes, specimen collection, comparison of diagnostic techniques

2. Viral Pathogens and Clinical Presentation

Respiratory Viruses (Influenza virus, respiratory syncytial virus, human metapneumonvirus, rhinovirus, coronavirus, mumps virus)

Viruses with Dermatologic Manifestations (Herpes simplex virus, varicella-zoster virus, measles virus, rubella virus, human herpesviruses 6 and 7, smallpox virus)

Gastrointestinal and Fecal-Oral Hepatitis Viruses (Rotavirus, norovirus, astrovirus, HAV, HEV)

Viruses causing Multiple Syndromes (Enterovirus, adenovirus, parvovirus B19, human bocavirus)

Opportunistic, Transplant-Associated Viruses (Cytomegalovirus, BK virus, JC virus)

Blood-Borne Hepatitis Viruses (Hepatitis B, C, and D viruses)

Human Retroviruses (HIV, HTLV-1/-2)

Oncogenic Viruses (HPV, EBV, HHV-8)

Zoonotic Viruses (Rabies virus, Ebola virus, Marburg virus, Lassa virus, Crimean Congo hemorrhagic virus, hantavirus, lymphochoriomeningitis virus, monkeypox virus, herpes B virus, Hendra virus, Nipah virus)

3. Diagnostic Assays and Techniques

Culture- and Tissue-Based Diagnostic Techniques (Conventional viral culture and cell lines, viral growth rates, hemagglutination, quantification of plaques)

Diagnostic Techniques Based on Immunological Interactions (Kinetics of immune responses, interpreting serologic results, antigen and antibody detection, ELISA and chemiluminescent immunoassay, immunohistochemistry, immunoblots, immunofluorescence, lateral-flow assay, comparison of immunologic assays)

Molecular Techniques: (Basics of nucleic acids, nucleic acid amplification, PCR, RT-PCR, real-time PCR, quantitative PCR, melt curve analysis, viral loads, droplet digital PCR, nested PCR, multiplex PCR, transcription-mediated amplification, controls, contamination, Sequencing (Sanger, NGS, Illumina, SMRT, Ion Torrent).

RECOMMENDED BOOKS

1. R Khare. 2020. Guide to Clinical and Diagnostic Virology. John Wiley & Sons, Inc
2. G. Kudesia and T. Wreghitt. 2009. Clinical and Diagnostic Virology. CAMBRIDGE UNIVERSITY PRESS UK.
3. L. R. Haaheim, J. R. Pattison and R. J. Whitley. 2003. A Practical Guide to Clinical Virology 2nd Edition. John Wiley & Sons Ltd, UK.

ZOO 612

IMMUNOLOGY

3 (3+0)

Objectives: The course aims to:

- Give understanding of the basic concepts of immunology and its importance in biological sciences
- Provide information about immunological mechanisms against different diseases
- Give understanding of immunization, immunological tolerance etc.

Course Contents:

Immunology: Immunobiology, Immunophysiology, Immunopathology.

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

Antigens and elicitation of immune responses: antigens and their types, antigenicity and immunogenicity, factors important for immunogenicity of an antigen, cell mediated and humoral: nature of antigens, genetic constitution of individuals and route of administration.

Immunoglobulins: Synthesis of antibodies, Theories of antibodies synthesis.

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

Monoclonal antibodies: Importance, synthesis, isolation and applications

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

Cellular basis of immune response: Origin of lymphocytes, Primary and secondary lymphoid organs, Specific response of individual lymphocytes to antigenic stimulation, Histological features of immune response.

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

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

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

Immunization; Immunization procedures, Vaccines and their types.

Books Recommended

1. [Jenni Punt](#), [Sharon Stranford](#), [Patricia Jones](#) · 2018. Kuby Immunology. Macmillan Learning USA
2. [Jeffrey K. Actor](#). 2014. Introductory Immunology. [Elsevier Health Sciences](#)
3. [Peter J. Delves](#), [Seamus J. Martin](#), [Dennis R. Burton](#) · 2017. Roitts Essential Immunology. 2nd ed. Black well Scientific Publications. Oxford, UK.
4. [Mark Peakman](#), [Diego Vergani](#) · 2009. Basic and Clinical Immunology 2nd Edition . [Elsevier Health Sciences](#)

ZOO 613 ANATOMY AND PHYSIOLOGY OF AMPHIBIANS 3(3+0)

Objectives

1. Enable the students to learn about the structure and function of organs and organ systems of the amphibians
2. Gain knowledge necessary and pre-requisite for advanced research and finding of structure and function relationship of animals and its practical application
3. Graduates studying such course will be able to use amphibians as an experimental system to learn and interpret about the broad evolutionary and physiological processes of animals in general.
4. They will be able to use amphibians to evaluate enzymatic, pharmacological, physiological role of many substances newly extracted or synthesized.

Course outline

The integumentary system: structure and function of skin, glands, integumentary derivatives, role in defense; **The respiratory system:** skin and respiration, the pulmonary respiration; **The digestive system:** structure and function of alimentary canal, the digestive glands, the enzyme machinery; the absorption; **The cardio-vascular system:** structure and function of arteries, veins and capillaries, the lymphatic system, the heart; **The excretory system:** structure of kidney and the associated ducts, urine formation; **The nervous system:** the spinal and cranial nerves, the spinal cord, the brain; **The Reproductive system:** structure of testes, ovaries, glands and ducts; **The musculoskeletal system:** muscles; smooth and striated, the skeleton, bone types; **The endocrine systems:** pituitary, thyroid, adrenal gland, pancreas; The special sense organs: **Eye;** anatomy and physiology; **Ear:** anatomy and physiology; **Tongue;** anatomy and physiology.

Literature Recommended

1. Girling, S.J. (2013). Basic Reptile and Amphibian Anatomy and Physiology. doi.org/10.1002/9781118782941.ch17
2. Stebbins, R.C. and McGinnis (2012). Taxonomy, Anatomy, Physiology, and Behavior of Amphibians in [Field Guide to Amphibians and Reptiles of California](https://doi.org/10.1525/9780520949973-010). doi.org/10.1525/9780520949973-010
3. Loft, B. (1976). Physiology of the Amphibians. 1st ed. Academic press.
4. Henry, P.F.P. (2000). Aspects of Amphibian anatomy and physiology. Society of Environmental Toxicology and Chemistry
5. Warburton, S. and Burggren, W. W. (2007). Amphibians as model animals for laboratory research in physiology. ILIAR Journal, 48 (3): 260-269.
6. *de Andrade, D. V., Bevier, C. R. and de Carvalho, J. E. (2016). Amphibian and Reptile Adaptations to the Environment.* <https://doi.org/10.1201/9781315373638>

Zoo 614 ANATOMY AND PHYSIOLOGY OF REPTILES 3 (3+0)

Objectives

1. Enable the students to learn about the structure and function of organs and organ systems of the reptiles
2. Gain knowledge necessary and pre-requisite for advanced research and finding of structure and function relationship of animals and its practical application

habitat, pestiferous nature, status as biological control agent, economic importance

Squamata: freshwater, marine and terrestrial lizards and snakes-their description and key identification characters in wild, distribution ranges, ecological role; feeding, enemies, exotic or native status, habitat, pestiferous nature, status as biological control agent, economic importance; **Crocodylians:** description and key identification characters in wild, distribution ranges, ecological role; feeding, enemies, habitat, economic importance

Chelonia: freshwater, marine and terrestrial turtles and tortoises-their description and key identification characters in wild, distribution ranges, ecological role; feeding, enemies, exotic or native status, habitat, economic importance, Threats.

LITERATURE RECOMMENDED

1. Masroor, R. (2012). A contribution to the herpetology of Northern Pakistan: The amphibians and reptiles of Margalla Hills National Park and Surrounding Regions. Society for the study of amphibians and reptiles.
2. Khan, M.S. (?). Herpetology of Pakistan. 1st ed. Zoological Soc. of Pak. Lahore. Pakistan
3. Mattison, C. (1992). Lizards of the World. Blandford Press.
4. Alderton, D. (1988). Turtles and tortoises of the world. Blandford Press, London
5. Alderton, D. (1991). Crocodiles and Alligators of the world. Blandford Press, London
Gunther, Albert (1964). Reptiles of British India. Oxford and IBH Publishing Co., New

ZOO 616

ADVANCED SYSTEMATICS AND PHYLOGENETICS OF HERPTILES

3 (3+0)

Objectives

1. The course will enable to understand the systematics and evolutionary aspects of amphibians in detail.
2. It will help learn the traditional as well as modern methods of classification and cladistics of amphibians and reptiles.

COURSE OUTLINE

Biosystematics: definition, history, traditional systematic approaches; phenetic, cladistics and evolutionary approaches

Methodological considerations: comparison of traditional and modern phylogenies of herps, traditional and molecular systematic methods,

systematics of Amphibia: classification, taxonomy, evolution and phylogeny

Systematics of Reptilia: classification. Taxonomy, evolution and phylogeny

Systematics and Conservation: role of systematics in conservation, case studies of taxonomic revisions and conservation.

Biosystematics today: genomic and proteomic approaches to herptile systematics

Literature Recommended

1. Carroll, R. (2009). The rise of amphibian evolution: 365 million years of evolution. The John Hopkins University Press.
2. Zhang, P., Zhou, H., Chen, Y., Liu, Y. and Qu, L. (2005). Mitogenomic perspectives on the origin and phylogeny of living amphibians. Systematic Biology, 45 (3): 391-400.

3. Milner, A. and Benton, M.J. (1988). The relationship and origin of the living amphibians: the phylogeny and classification of the tetrapods. Claredon Press pp. 59-102.
4. Rodda, G.H. (2020). Lizards of the world: Natural history and taxon accounts. Johns Hopkins University Press.
5. Frost, D.R. and Ethridge, R. (1989). A phylogenetic analysis and taxonomy of iguanid lizard (Reptilia: Squamata). Museum of Natural History.

ZOO 617 MOLECULAR GENETICS 3 (3+0)

Course Objectives and Learning Outcomes:

The objectives of the course are:-

1. To understand the organization of human nuclear genome and mitochondrial genome.
2. To develop understanding of different types gene families and superfamilies'
3. To equip the student with different modern molecular Techniques.

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

- **Acquire** the basic knowledge of human nuclear genome and mitochondrial genome.
- **Illustrate** the key features of human genome and certain gene families.
- **Discover** the role of certain RNA coding genes along with protein coding genes.
- **Investigate** certain molecular problems with the help of modern molecular techniques.

Course Outline:

Genome structure: Human mitochondrial genome. Human Nuclear genome. Protein Coding gene. RNA genes.

Gene Families: Solitary gene and gene family, Gene superfamily. Pseudogenes. Retrogenes. Cluster gene families. Interspersed gene families

Transposable Genetic Elements: LINES, SINES, Fossil Transposons

Repeat Instability and Genetic Disorders: TRED1. TRED2. Fragile X- Syndrome. Mytonic Dystrophy

Study of Molecular Techniques: Southern blotting. Western blotting, Northern blotting, RFLP, RAPDS, Microsatellite DNA

Text and Reference Books:

1. Alberts, B., A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc. New York. 2002.
2. Watson, J.D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick. Molecular biology of the gene. Pearson Education. 2004.
3. Snyder, L. and W. Chapness. Molecular Genetics of bacteria. ASM, Press, 2003.
4. Lewin, B. Gene-VIII. Oxford University Press, Oxford, UK. 2004.

ZOO 618 APPLIED GENETICS 3 (3+0)

Course Objectives and Learning Outcomes:

The objectives of the course are:-

1. To give basic understanding of genetic transformation processes.

2. To develop understanding of Transposable elements and their mechanism of Transposition
3. To enable the students to understand the genetic factors influencing human development and behavior.

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

- **Describe** the phenomenon involved in transformation of genetic material.
- **Understand** the Transposable elements and bacterial transposition.
- **Interpret** the regulation of gene expression in prokaryotes and eukaryotes.
- **Outline** the roles of various genes and genetic factors in development and human behavior.

Course Outline:

Nucleic acids. a. Plant and animal viruses b. Tumor viruses c. Retroviruses

Genetic Transformation: a. Conjugation b. Transformation c. Transduction d. Integration of viral DNA

Transposition: a. Transposable Elements b. Detection of Transposition In Bacteria c. Types of Bacterial Transposons d. Modes of Transposition In Bacteria

Gene expression: a. Regulation of Gene expression in Prokaryotes
b. Regulation of gene expression in Eukaryotes

Quantitative Genetics of Human Behavior: a. Intelligence
b. Personality

A genetic perspective on development: a. Maternal effect genes
b. Determination of dorsal-ventral and anterior posterior axis c. Body segmentation d. Organ formation

Text and Reference Books:

1. Alberts, B., A. Johnson, J. Lewis, M. Raff, K. Roberts, and P. Walter. Molecular Biology of the Cell, 4th Ed. Garland Publishing Inc. New York. 2002.
2. Watson, J.D., T.A. Baker, S.P. Bell, A. Gann, M. Levine, and R. Losick.
3. Molecular biology of the gene. Pearson Education. 2004.
4. Snyder, L. and W. Chapness. Molecular Genetics of bacteria. ASM, Press, 2003.
5. Lewin, B. Gene-VIII. Oxford University Press, Oxford, UK. 2004.

ZOO 619

LAB AND BIOSAFETY

3(3+0)

Course Objectives and Learning Outcomes:

The objectives of the course are:-

1. To impart knowledge to the students about biohazards, laboratory associated risks, risk assessment, safety issues, biosafety levels and role of biosafety committees
2. To create awareness about the safety involved in handling chemical, radioactive and biohazardous materials in the lab
3. To provide guidelines on how students can protect themselves and their workplace from physical, chemical, electrical and bio-hazards

4. To demonstrate the proper use of PPE, safety equipment, best lab practices, biological containment, biosafety requirements, storage, transportation and disposal of biohazardous waste

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

- **ATTAIN** the practical knowledge of the safety equipment in the lab and use them efficiently.
- **COMPREHEND** the concepts of risk groups, risk assessment and biosafety levels.
- **APPREHEND** the principles of good lab practices and to ensure that adequate biosafety requirements are in place.
- **ELUCIDATE** the role and responsibilities of biosafety committees in research labs.
- **CONSIDER** the key safety issues and health problems related with lab acquired infections.
- *ASSESS* the *hazards* and *potential risks* associated with the chemicals and *laboratory* operations.
- **CONTRIBUTE** to the development of contingency plans and emergency procedures for lab safety.
- **DEMONSTRATE** Biosafety Policy, Codes of Practice and National Biosafety Guidelines.

Course Outline:

Introduction and History: a. Introduction to biosafety, biological and biohazardous materials
b. History of biosafety, biological warfare, bioterrorism
c. Biosafety containment levels and controls
d. Classification of Risk groups
e. Risk assessment for chemical hazards and biohazards

Laboratory Associated Risks: a. Lab Acquired Infections (LAIs)
b. Blood borne Pathogens
c. Descriptive epidemiology of occupational infections of laboratory workers
d. Route of transmission and modes of exposure
e. Emergencies: accidents, incidents, chemical/microbial spills and exposures
f. Chemical fire and electricity safety

Lab Safety and Compliance Requirements: a. Personal Protective Equipment (PPE)
b. Lab Facilities and Safety Equipment
c. Disinfection, Decontamination and Sterilization
d. Contingency plans and emergency procedures
e. Practices for handling and disposal of infectious materials
f. Packaging, labeling, storage, transportation and disposal of lab waste/infectious agents

Lab Biosafety Guidelines: a. Safety management
b. General biosafety principles and requirements
c. Laboratory permits and registration of biological, chemical and radioactive materials
d. Biosafety Policies and Codes
e. National Biosafety Guidelines

Role and Responsibilities of Biosafety Committees: a. Occupational Safety and Health Administration (OSHA)
b. Cartagena Protocol on Biosafety (CPB)
c. National Biosafety Committee (NBC)
d. Technical Biosafety Committee (TBC)
e. Institutional Biosafety Committee (IBC)

Text and Reference Books:

1. Biosafety in Microbiological and Biomedical Laboratories, 5th ed., (2009) by L. Casey Chosewood and Deborah E. Wilson, U.S. Department of Health and Human Services, Public Health Service Centers for Disease Control and Prevention, National Institutes of Health, HHS Publication No. (CDC) 21-1112.
2. Labsafety Manual (2006) by Smida, A., Department of Health, Safety and Environment, University of Saskatchewan, Saskatoon, Canada.

3. Biological Safety, Principles and Practices, 4th ed.(2006) by Fleming & Hunt, ASM Press.
4. Biosafety Manual (2005) by Oles, A., Department of Health, Safety and Environment, University of Saskatchewan, Saskatoon, Canada.
5. National Biosafety Guidelines (2005), Pakistan Environmental Protection Agency, Government of Pakistan.
6. Laboratory Biosafety Manual, 3rd ed.(2004) by World Health Organization (WHO), Geneva.

ZOO 620 RESEARCH METHODS IN ENTOMOLOGY 3(3+0)

AIMS AND OBJECTIVES

To enable students, get familiarized with modern equipment used in Entomological Research and provide concept of software in data analysis.

COURSE CONTENTS

Introduction; techniques and apparatus employed in entomological research: temporary and permanent mounts, microtomy, use of ocular grid, micrometry and scientific photography; bio-assay techniques; atomic absorption spectrophotometer, gas chromatography, high performance

liquid chromatography, UV-visual spectrophotometer, amino acid analyzer, electrophoresis, PCR, recombinant DNA techniques, ultra-centrifugation, scanning and transmission, electron microscopy and computer software in entomology; methods of sampling, analysis of data and report writing; lab/field experimental techniques.

Books Recommended

1. Bancroft, J.D. and Stevens, A. 1990. Theory and Practice of Histological Techniques. Chaschill Livingstone, London.
2. Binns, M.R. 2000. Sampling and Monitoring in Crop Protection. CABI Publishing Company
3. Capiello, A. 2007. Advance in LC-MS Instrumentation. Elsevier Publishers, USA.
4. Erlich, H. 1992. PCR Technology: Principles and Applications for Amplification. W.H. Freeman & Company, New York.
5. Singh, P. and Moore, R.F. 1985. Handbook of Insect Rearing. Vol, I & II, Elsevier, U.S.A.

ZOO 621 VECTOR BIOLOGY 3(3+0)

AIMS AND OBJECTIVES

- Provide in-depth appreciation of diseases transmitted by invertebrate vectors
- Impart knowledge about control of vector-borne disease

COURSE CONTENTS

Vector Biology and Control - key aspects of vector taxonomy, evolution, biology and

behavior. An introduction to the life-cycles of vectors, their ecology, role in transmission of various diseases. Major groups of arthropod-borne pathogens and vectors.

Basic components of arthropathogen disease cycles and principles of pathogen transmission dynamics.

Emergent pathogens. Vector genetics. Vaccines for vector-borne disease Traditional and modern disease control strategies and venomous arthropods.

Biology and Ecology of some vectors of medical importance (order Diptera): Mosquitoes; (Anopheles culicine) 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, warable flies and bot flies). The study will cover following aspects: Morphology, anatomy, distribution, breeding habits, life-cycle 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.

Books Recommended

1. Handler, A. M. James, A.A. (Eds.).2004. Insect Transgenesis: Methods and Applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues. CRC Press.
2. Hoy, M.A.2000. Insect Transgenesis: Methods and Application. CRC Press.
3. Pedigo, L. P. 2003. Entomology and Pest Management. 4th ed. Pearson Education, Singapore, Pvt. Ltd.
4. Roy, D. N. and Brown, A.W.A .2004. Entomology. Biotech .Books, New Delhi.
5. Peter, W. Atkinson., 2010. Vector Biology, Ecology and Control. Springer Dordrecht Heidelberg, London, New York.
6. William, H. Marquardt, *et al.*, 2004. Biology of Disease Vectors. 2nd Edition.
7. William Charles Marquardt, Richard S. Demaree, Jr., Robert Burton Grieve., 2000. Parasitology & Vector Biology. 2nd Edition.

ZOO 622

INSECTS OF MEDICAL AND VETERINARY IMPORTANCE

3(3+0)

AIMS AND OBJECTIVES

- Provide knowledge about insect vectors, disease borne pests of veterinary and human importance
- Understand their life cycles as they carry viruses and other organisms during transmission of diseases
- Impart knowledge about their control

COURSE CONTENTS

General introduction to medical and veterinary entomology: phylum arthropoda, salient features of insects, classification, general morphology and physiology of insects, modifications in mouthparts and appendages of insects, metamorphosis and its types.

Insects of medical and veterinary importance: mosquitoes, human louse, houseflies, fleas, bugs, mites and ticks: life cycles, diseases and their control. Insect venoms; bees, wasps, ants. Insect toxins, arthropod allergens. Insect pest management: definition, principles and methods of insects control, components of pest management, techniques, general measures to control insects, economics of pest management.

Books Recommended

1. Roy, D. N. and Brown, A.W.A .2004. Entomology. Biotech .Books, New Delhi.
2. Chandler, A.C. and Read, C.P. 1961. Introduction to Parasitology. 10th ed. Wiley Toppan, New York, USA
3. Rozendael, J. A. 1999. Vector ConlJ19l. A I. T. B. S. publishers, New Delhi.
4. Service, M.W. 1996. Medical Entomology. Chapman and Hall, USA
5. Pedigo, L. P. 2003. Entomology and Pest Management. 4th ed. Pearson Education, Singapore, Pvt. Ltd.

ZOO 623

MOLECULAR ENTOMOLOGY

3(3+0)

AIMS AND OBJECTIVES

To provide the modern molecular concepts of Insect Genome System and its applications in Bio-diversity studies.

COURSE CONTENTS

Introduction; insect genomes; nucleus, chromosomes, DNA and RNA; Gene structure and function; gene transcription and translation; concept of introns 123 and exons; central dogma of molecular biology; polymerase chain reaction (PCR), gene cloning and sequencing; restriction analysis, gene libraries; DNA for insect species identifications and insect population diversity; DNA for phylogenetic analysis and construction of phylogenies; RAPD, RFLP and PCR-RFLP; linkage and chromosomal mapping, genes regulatory processes, mutagenesis; molecular basis of insect functions (insect behavior, insecticidal resistance), gene knock-ins and knock-outs by RNA interference, DNA and protein sequence alignments and use of bioinformatics tools.

Books Recommended

1. Gilbert, L. 2005. Comprehensive Molecular Insect Science.1-7 Vol.
2. Glick, B.R. and Pasternek, J..J. 1998. Molecular Biotechnology:
3. Principles and Applications of Recombinant DNA.ASM Press.Washington D.C.
4. Hall, B.G. 2007. Phylogenetic Trees Made Easy: A How to Manual. 3rd Ed. Sinauer Associates.
5. Handler, A. M. James, A.A. (Eds.).2004. Insect Transgenesis: Methods and Applications, Comprehensive review of insect gene transfer, its methodologies, applications and risk assessment and regulatory issues. CRC Press.
6. Hoy, M.A.2000. Insect Transgenesis: Methods and Application. CRC Press.

ZOO 624

MOLECULAR BIOLOGY

3 (3+0)

Aims and objectives.

1. An understanding of how molecular mechanisms are constructed and regulated
2. knowledge about different molecular biological techniques.
3. To provide knowledge regarding structural / storage components of basic unit of life at molecular level also

COURSE OUTLINE

Introduction of major biological molecules. The Nucleic Acid DNA primary structure: the components of nucleic acids. Five-carbon sugars Nitrogenous bases. The phosphate functional group Nucleosides and nucleotides, Significance of 5' and 3', Nomenclature of nucleotides The length of RNA and DNA, Secondary structure of DNA, Hydrogen bonds form between the bases, Base stacking provides chemical stability to the DNA double helix, Structure of the Watson–Crick DNA double helix, Slipped structures, Cruciform structures, Triple helix DNA, Supercoiling of DNA, Introduction to RNA, Types of RNA, Secondary structure of RNA ,Secondary structure motifs in RNA,Tertiary structure of RNA, tRNA structure: important insights into RNA structural motifs Common tertiary structure motifs in RNA, RNA involvement in a wide range of cellular processes , DNA replication ,General Features of DNA Replication , Semiconservative Replication, Bidirectional Replication ,Rolling Circle Replication Three DNA Polymerases in E. coli , Fidelity of Replication. RNA synthesis transcription of mRNA, rRNA, t-RNA. Protein. The central dogma, the genetic code, translating the genetic code, Protein structure, Primary structure, Secondary structure, Tertiary structure, Quaternary structure Size and complexity of proteins, Proteins contain multiple functional domains Prediction of protein structure, Protein function

Books Recommended.

1. Alberts B., Johnson, A., Lewis, J., Raff, M., Roberts, K and Walter, P., 2002. Molecular Biology of Cell. Garland Science, New York.
2. Robert F.W., 2005. Molecular Biology . McGraw-Hill.
3. Primrose, S.B., and Twyman, R.M. 2006. Gene Manipulation and Genomics 6th edition. Blackwell Publishing

ZOO 625

OVERVIEW OF CELL BIOLOGY

3 (3+0)

Aim and objective.

- The student will understand the basic component and structure of a cell
- This course will enable the students to study the working of life processes at cellular level.
- This will clear the concept why the cell is basic and functional unit of life.

Course Outlines

Historical account of cell biology; cell theory and protoplasm theory, Cell types, cell chemical composition, major organic molecule of cell, Plasma membrane molecular architecture, ultrastructure of plasma membrane, models presented for the structure of plasma membrane, membrane fluidity mechanism ,major phospholipids of plasma membrane major protein of the plasma membrane, receptors of plasma membrane and function o plasma membrane, transport mechanism of the plasma membrane, role of membrane channels in transmission of nerve impulse, major enzymes of the plasma membrane, receptor mediated endocytosis. Endoplasmic reticulum structure and types, detoxification mechanism of endoplasmic reticulum, protein synthesis and protein translocation of endoplasmic reticulum. Golgi complex structure and its role in cell secretion, Lysosome structure and chemical composition , lysosome

role in human diseases and syndrome, peroxisome and glyoxysome, peroxisome genesis mechanism, role of peroxisome in hydrogen peroxide production and detoxification, mitochondria structure and chemical composition, mitochondria and cell injury, endosymbiotic theory of mitochondria, mitochondria enzymes, mitochondria ribosome, Mitochondria DNA, biogenesis of mitochondria, mitochondria as power house of a cell, oxidative phosphorylation mechanism, ribosome structure and chemical composition, genesis of ribosome, role of ribosome in protein synthesis, nucleus and nucleus components, nuclear membrane, nucleolus, chromatin network organization, chromosome morphology, types, centromere, telomere, special chromosome, cytoskeleton, cell junctions

BOOKS RECOMMENDED

1. Karp. G, Iwasa. J, Marshall. W. Cell and Molecular Biology. Willey direct, 2021
2. Lodish. H, Berk. A., Kaiser. C.A, Krieger. M, Bretscher. A; Ploegh. P, Martin. K. C, Yaffe. M, Amon. A. Molecular cell biology. Macmillan, 2021
3. Alberts. B, Johnson. A, Lewis. J, Raff. M, Roberts. K, and Walter. P. Molecular Biology of Cell. Garland Science, New York. 2016

ZOO 626

GENERAL TOXICOLOGY

3 (3+0)

Aim and objectives

The course provides knowledge and understanding about the different carcinogenic, mutagenic and teratogenic agents.

Student will learn about the mode of action and the effects of different chemicals on living cell.

Comprehend in details the how the various toxin interferes in life process

COURSE OUTLINE.

Introduction to toxins and toxicology, Early development, Recent Development and Challenges in toxicology. Absorption, distribution and Excretion of Toxicants Biotransformation of Toxicants, Phase I and Phase II reactions. Effect of Toxicity: Spectrum of Toxic effects, Target organs, Mechanisms of Action, Molecular Targets including proteins and Co-enzymes. Modifying factors of Toxic effects: Host factors, Environmental effects, Chemical Interactions, Toxicity Studies: Acute and Chronic Toxicity Studies, Experimental Designs. Developmental Toxicity. Mutagenesis: Mechanisms, Introduction to In vivo and In vitro tests utilizing Bacteria, yeast, Insects and Mammals. Detoxification: Host and Environmental factors, histopathology lesion types, hepatic toxicology, renal toxicology, neurotoxicology, Introduction to antidots and its mechanism Bioindicators and Biomarkers. Introduction to genotoxicology, types of genotoxin, DNA repair mechanism, DNA repair types, Mechanism of DNA damage by oxygen reactive species and Radiations, Ecogenotoxicology, Consequences of genotoxicity, Genotoxicity testing techniques, comet assay, micro nucleus assay, Sister chromatid exchanges assay, ames test, bacterial mutation reverse test. Developmental toxicology and teratogens, Necrosis, Immunotoxicology, Effects on Development, Behavioral Effects.

BOOKS RECOMMENDED

1. Taylor and Francis: Fundamentals of Aquatic Toxicology: Effects, Environmental Fate and Risk Assessment. 2nd Edition, Philadelphia, London
2. Mikko Nikinmää . An introduction to Aquatic Toxicology, Elsevier. 2014
3. Stine K.E and Brown.T.M Principles of Toxicology, CRC press. 2015

ZOO 627 FISH AND AQUATIC TOXICOLOGY 3 (3+0)

Course Objectives:

The objectives of the course are:

1. To review the basic toxicological principles of uptake, elimination, and bioaccumulation, emphasizing processes unique to aquatic organisms.
2. To learn the relationships between abiotic and biotic processes of aquatic environments and their effects on contaminant distribution and subsequent exposure, accumulation, and toxicity in aquatic environments.
3. To become familiar with the concept of risk assessment and to extend its use to assess ecological risks resulting from aquatic pollution.

Course Learning Outcomes:

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

1. Acquire the knowledge of the various toxic agents and their sources in aquatic ecosystem
2. Understand the effects of toxic substances on fishes and other aquatic organisms
3. Solve the pollution problems in aquatic system
4. Analyze the toxicity on different organs of fish
5. Evaluate the bioaccumulation pattern of pollutants in aquatic organisms
6. Develop critical thinking to solve aquatic pollution problems

Course Outline:

1. Introduction to Aquatic Toxicology

- a. History of Aquatic Toxicology
- b. Main Present and Future Challenges
- c. Classification and Types of Toxicity
- d. Effects of Aquatic Toxicology on Organisms
- e. Bioindicators and Biomarkers

2. Sources and Causes of Aquatic Contamination

- a. Major Sources of Pollutants
- b. Transport of Pollutants in the Environment
- c. Metals, Metalloids, and Organometallic Compounds
- d. Other Inorganic Compounds, Including Factors Causing Eutrophication
- e. Organic Compounds
- f. Nanomaterials
- g. Radiation
- h. Genetic Modification

3. Uptake, Distribution, Detoxification and Excretion of Compounds in Aquatic Organisms

- a. Uptake of Compounds by Organisms
- b. Distribution and Storage Sites of Chemicals in Organisms
- c. Biotransformation and Detoxification
- d. Cellular Excretion

- e. Excretion from Gills, Kidney and Other Excretory Organs
- f. Excretion in Bile Via the Intestine
- g. Excretion from Multicellular Plants and Algae
- 4. General Principles of Toxicology in Fishes**
- a. Bioavailability of Chemical Contaminants in Aquatic Systems
- b. Toxicokinetics in Fishes
- c. Toxicodynamics in Fishes
- d. Biotransformation in Fishes
- e. Bioaccumulation of Toxicity in Fishes
- f. General approaches to diagnosis and treatment of toxicity
- 5. Toxicity in Fishes**
- a. Toxicity caused by metal and non-metals,
- b. Phytotoxins
- c. Drug toxicity and toxicity caused by agrochemicals.
- d. Mycotoxins
- e. Bacterial toxins
- 6. Key Target System in Fish and Organismal Effects**
- a. Liver Toxicity in Fishes
- b. The Osmoregulatory System of Fish
- c. Toxic Responses of the Fish Nervous System
- d. The Endocrine System
- e. The Immune System of Fish: A Target Organ of Toxicity
- f. Chemical Carcinogenesis in Fishes
- g. Toxicity Resistance in Fishes

REFERENCE BOOKS:

1. Malins, D. C., 2018. Aquatic Toxicology: Molecular, Biochemical, and Cellular Perspectives. CRC press.
- 2- Nikinmaa, M., 2014. An Introduction to Aquatic Toxicology. 1st Ed. Academic Press.
- 3- Whitacre, D. M. (Editor) 2012. Reviews of Environmental Contamination and Toxicology. Vol. 223. Springer, Switzerland.
4. Giulio, R.T.D. and Hinton, D.E., 2008. The Toxicology of Fishes. CRC Press,
- 5- Marquardt, H., Schafer, S.G., McClellan, R. and Welsch, F., 1999. Toxicology, Academic press, San Diego.
- 6- Rand, G.M., 1995. Fundamentals of Aquatic Toxicology: Effects, Environmental Fate and Risk Assessment. 2nd Ed. CRC press.

ZOO 628 FISH PARASITOLOGY 3 (3+0)

Course Objectives

The objectives of the course are:

1. To familiarize the students with common parasites of fish and their treatment methods
2. To equip students with a fundamental understanding of science and competence in parasitological methods.
3. To provide advanced knowledge, understanding, and critical judgment appropriate for professional employment in the field of Parasitology or a related discipline.

Course Learning Outcomes:

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

1. Describe the life cycles of different fish parasites
2. Solve the problems of identification of fish parasites with the help of latest illustrations in the field of fish parasitology.
3. Prepare the slides of nematodes, cestodes and trematodes for identification
4. Demonstrate the location of various endoparasites by dissecting the fish.

COURSE OUTLINES:

1. Introduction to fish parasitology

- a. Host and parasite relationship
- b. Types of host and parasite
- c. Ectoparasite and endoparasite concepts
- d. Overview and Adaptation,
- e. association of parasites:
- f. symbiosis, commensalism, mutualism, parasitism.

2. Fish parasites

- a. Classes of fish parasites
- b. Identification of parasitic problems.
- c. Methods of diagnosis, physical examination, Pathogenesis
- d. Life cycles and treatment methods of following parasites:
Protozoa, Monogenean and Digenean trematodes, Nematodes, Cestodes, Crustaceans, Leeches.

3. Parasite Treatment and control

- a. Prophylactic measures
- b. Treatment of fish parasites

Recommended Books

1. Patrick T. K. W. and K. Buchmann., 2012. Fish parasites: pathobiology and protection. CABI Publishers
2. Bresciani, J., E. Ariel, K. Pedersen, I. H. Dalsgaard., 2009. Fish Disease: an introduction. CABI Publishers
3. Buchmann, K., 2007. An introduction to practical methods in fish parasitology. CABI Publishers
4. Bremner, H. A., 2002. Safety and Quality Issues in Fish Processing. Woodhead Publishing Limited, Cambridge, England

ZOO 629 FISH PROCESSING AND VALUE ADDITION 3(3+0)

Course Objectives:

The objectives of the course are:

1. To familiarize the students with the advancements in the fields of fish processing and post-harvest technology of freshwater and marine fish.
2. To provide an exposure on the various advanced preservation techniques of fish and fish products.
3. To learn the importance of an efficient post-harvest and fish marketing chain in accordance with consumer needs.

Course Learning Outcomes:

Upon successful completion of the course students will be able to:

1. Acquire advanced knowledge about fish processing and post-harvest technology.
2. Learn techniques of preservation of fish and fish products.

3. Demonstrate the working of various landing sites and fish processing plants.
4. Develop various value-added fish products and recipes.

Course Contents:

1. Introduction to fish processing and value addition.
2. Quality of fresh and frozen fish.
3. Methods of assessing and selecting for quality microbiology of products.
4. Assessment of heavy metals in fish and shellfish.
5. Modern methods of fish handling and hygiene.
6. On board handling and on shore fish handling.
7. Icing procedures.
8. Transportation to fish markets.
9. Various ways of fish disposal.
10. Fish preservation and traditional processing methods (salting, curing, sun-drying, smoking, etc.), fish filleting and packing.
11. Shelf life of fish food products.
12. Packaging.
13. Deep freezing and thawing.
14. Chemistry of freezing.
15. Development of value added fish products; pickling, fish pastes, special processing procedures (minced fish, minced based value addition, fish surimi and surimi based products, gelatin).
16. Industrial fish processing; Fish meals, fish oils, fish protein concentrate.
17. Fish by products.
18. Food certification International standards (ISO, HACCP, Halal certification etc.)
19. Food safety and laws.
20. Live fish handling, marketing.
21. Fish import and export International and National laws

RECOMMENDED BOOKS:

1. FDA. 2020. Fish and Fisheries Products; Hazards and Control Guidance 4th Ed. US Dept. of Health and Human service, Food and Drug Administration.
2. Leonard, B., 2011. Fish and Fishery Products. DIANE Publishing.
3. Horner, W. & Robles, R., 2007. Fish Products and Processing. Blackwell Publications.
4. Bremner, H. A., 2002. Safety and Quality issues in fish processing. Woodhead Publishing Limited, Cambridge, England.
5. Pearson, A.M. and Dutson, T.R., 2002. HACCP in Meat, Poultry & Fish Processing. Kluwer Academic Publishers
7. Connell, J.J., 2001. Control of Fish Quality. Blackwell Science.
8. Kestin, S.C. and Warriss, P.D., 2001. Farmed Fish Quality. Fishing News Books.
9. Pearson, A. M. and Dutson, T.R. 1999. HACCP in Meat, Poultry and Fish Processing. Advances in Meat Research Series. Vol. 10. ASPEN publication.
10. Martin, R.E., Collette, R.L. and Slavin, J. 1997. Fish Inspection, Quality Control, and HACCP, A Global Focus. Technomic Publishing Co. Inc.

ZOO 630 FISH NUTRITION AND HEALTH 3 (3+0)

Course Objectives:

The course is designed to familiarize students with:

1. Physiological aspects of nutrition and response of fish to diet in relation to feed additives

and immunity.

2. Recent advancement in aquaculture nutrition, nutritional constituents and their energetics, nutritional deficiency, and diseases.
3. Fish feed formulation procedures and processing practices.
4. Risk associated factors to the aquaculture nutritional balance and management of the feed stocks

Course Learning Outcomes:

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

1. Acquire knowledge about fish nutrition and methods of feeding for sustainable fish production.
2. Interpret various macro and micro-nutrients, energetics and digestibility of nutrients.
3. Demonstrate manufacturing techniques of various types and size of fish feed, feeding regimens in relation to the species cultured and the type of culture facility.
4. Locate feed additives and feeding stimulants to enhance fish growth and immune response.
5. Analyze anti-nutritional factors present in feed ingredients and toxic agents that affect fish growth.
6. Calculate feeding rations and feed conversion ratios
7. Identify factors affecting feed intake related to fish species and their life stages.

Course Outlines:

1. Introduction:

Introduction to nutrients (macronutrients and micronutrients) and their importance; carbohydrates, lipids, protein, amino acids, vitamins, minerals, carotenoids.

2. Nutritional energetic:

Digestion process in fish, energy partitioning, bioenergetics model, methods of digestibility determination, factors affecting digestibility, nutrient digestibility.

3. Types of fish feed:

Natural and artificial; production of live feed; classification of fish feed based on nutrient composition and texture.

3. Feed Additives and anti-nutritional factors:

Introduction to feed additives; other dietary components (water, fiber, hormones, antibiotics, pigments, pellet binders, stimulants). Anti-nutritional factors, types of antinutrients and their sources.

4. Toxic agents and anti-oxidants:

Introduction to Toxic agents, non-nutrient diet components; antioxidants in compounded feeds.

5. Nutritional disorders:

Nutritional fish diseases; nutrients and immune response; feed rancidity.

6. Feed Rationing and Frequency:

Feeding ratio; feeding frequency; feed conversion ratio; feed digestibility; pre-biotics and pro-biotics.

7. Novel diets for aquaculture:

Encapsulated diets, medicinal diets and experimental diets.

8. Aqua feed industry:

Introduction, economics of feed production and feeding; quality control in fish feed manufacturing; feed regulations.

Recommended Books:

1. Halver. J. 2013. Fish Nutrition, ELSEVIER.

2. Lovell, T., 2012. Nutrition and Feeding of Fish. 2nd Ed. Springer Science, USA
3. Stickney, R. R. 2009. Aquaculture: An Introductory Text. CABI Publishing, London, UK.
4. Pandey, B. N., S. Deshpande and P. N. Pandey. 2007. Aquaculture. APH Publishing Corporation, New Delhi, India.
5. Ojha, J.S. 2006. Aquaculture Nutrition and Biochemistry. Geeta Somani Agrotech Publishing

ZOO 631 VACCINES OF HUMAN PREVENTABLE DISEASES 3 (3+0)

The course aims to provide in-depth knowledge of the diseases, its occurrence, significance, etiology, pathogenesis, the available vaccines, the vaccination procedure and its efficacy. The course also aims to highlight the effect the vaccines have on the control and eradication and side effects / short comings of the vaccine if any. After completion of the course the student / scholar will be able to know about vaccines, its types, dosage, use and benefits of the vaccines that are in use in humans. He or she can become an advocate of the vaccination programs and thus help reduce the vaccine hesitancy found in the public.

Course Contents

Chickenpox (Varicella), Diphtheria, Flu (Influenza), Hepatitis A, Hepatitis B, Hib (*Haemophilus influenzae* type b), HPV (Human Papillomavirus), Measles, Meningococcal, Mumps, Pneumococcal, Polio (Poliomyelitis), Rotavirus, Rubella (German Measles), Shingles (Herpes Zoster), Tetanus (Lockjaw), Whooping Cough (Pertussis),

Adenovirus, Anthrax, Cholera, Japanese Encephalitis (JE), Rabies, Smallpox, Tuberculosis, Typhoid Fever, Yellow Fever, Corona Vaccines

RECOMMENDED BOOKS / FURTHER READING

1. Review of medical microbiology and immunology Warren, E. Levinson Peter Chin-Hong, Elizabeth Joyce, Jesse Nussbaum, Brian Schwartz 15th Edition 2018. Mc-Graw Hill Education.
2. Prescotts microbiology 10th edition 2012 Joanne M Willey, Linda M Sherwood, Christopher J Woolverton
3. Vaccinology: Principles and Practice edited by W. John W. Morrow, Nadeem A. Sheikh, Clint S. Schmidt, D. Huw Davies 2012 Blackwell publishing limited.
4. Janeway's Immunobiology Kenneth Murphy, Paul Travers, Mark Walport, Pater walter Taylor & Francis Group, 22-Jun-2010 .
5. Short Protocols in Immunology illustrated edition John E. Coligan. 2005 Wiley
6. Epidemiology and Prevention of Vaccine-Preventable Diseases, 13th Edition E-Book Jennifer Hamborsky, MPH, MCHES, Andrew Kroger, MD, MPH, Charles (Skip) Wolfe Public Health Foundation, 19-Oct-2015